JOURNAL AND PROCEEDINGS

—OF THE—

Hamilton Association

For the Cultivation of Science, Literature and Art

Hamilton, Canada

SESSION 1907-1908

NUMBER XXIV.

THE MUSEUM OF THE ASSOCIATION
IS IN THE PUBLIC LIBRARY BUILDING

AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR STATEMENTS MADE AND OPINIONS EXPRESSED THEREIN.

PRINTED FOR THE HAMILTON ASSOCIATION
BY HEATH & HIGNELL

1908

Officers for 1908-1909.

Honorary President
ADAM BROWN

President
A. ALEXANDER, F. S. Sc.

1st Vice-President
H. B. WITTON

2nd Vice-President
MATTHEW LEGGAT

Corresponding Secretary
G. PARRY JENKINS, F. R. A. S.

Recording Secretary
J. F. BALLARD

Treasurer
P. L. SCRIVEN

Curator
COL. C. C. GRANT

Council

LYMAN LEE, B.A.
JAMES GADSBY
A. H. BAKER
J. M. WILLIAMS
REV. W. DELOS SMITH

Journal and Proceedings

OF

The Hamilton Scientific Association

FOR SESSION OF 1907-1908.

NUMBER XXIV.

AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR STATEMENTS MADE AND OPINIONS EXPRESSED THEREIN.

PRINTED FOR THE HAMILTON SCIENTIFIC ASSOCIATION BY
HEATH & HIGNELL.

1908

ABSTRACT OF MINUTES

OF THE PROCEEDINGS OF THE

HAMILTON SCIENTIFIC ASSOCIATION

DURING THE

SESSION OF 1907-08.

THURSDAY, NOV. 8th, 1907

OPENING MEETING.

The Opening Meeting of our Association for the celebration of its Jubilee Year was held in the Recital Hall of the Hamilton Conservatory of Music this evening.

The preparation of the programme had been entrusted to A. Alexander, F. Sc. S., as the most active of the remaining Patriarchs of the Association, and the results were very gratifying.

President R. J. Hill occupied the chair and gave a brief address, after which, with a few appropriate remarks, he introduced the chief speakers, viz.: Mr. A. T. Freed, H. B. Witton, Ex.-M.P., and the Hon. Adam Brown, who had been selected as most thoroughly representative citizens for the occasion—Mr. Freed having taken a lifelong interest in the wellfare and advancement of our city. Mr. Brown, who besides being a charter member, was one of the Commissioners who fifty years ago gave us a waterworks system which, after a test of half a century, remains unsurpassed by any in its unity and completeness, and Mr. Witton, who from his scholarly attainments, his unflagging zeal in our behalf, and valuable original contributions to our Journal, is the most

highly esteemed of the Fathers of the Hamilton Scientific Association.

Nine new members were admitted.

The meeting was then declared open and representative members of the various sections gave expression to their feelings of congratulation, gratitude and hopefulness towards the parent Association.

A good musical programme was provided.

FRIDAY, DEC. 13th, 1907

REGULAR MEETING.

President R. J. Hill in the chair. Thirteen names were added to the list of membership. Dr. G. W. Johnston, of Toronto University, gave an elaborately prepared and very instructive lecture on Ancient Roman Art, which was illustrated by numerous hand-painted slides, receiving a hearty vote of thanks.

On motion of Mr. Witton, seconded by Geo. L. Johnston, the Corresponding Secretary was instructed to send a letter of condolence to the Widow of the late Geo. Low Reid, a very highly esteemed charter member.

FRIDAY, JAN. 17th, 1908.

REGULAR MEETING.

President R. J. Hill in the chair. J. G. Armstrong, Miss McKenzie and Miss Attridge were admitted to membership.

Prof. G. Oswald Smith, M.A., of Toronto University, gave an excellent and well illustrated lectrre on The Roman Occupation of Britain, receiving the thanks of the meeting for the instructive, interesting and stimulating nature of his remarks.

FRIDAY, FEB. 14th, 1908.

REGULAR MEETING.

President R. J. Hill in the chair. Two became members.

G. Parry Jenkins, F.R.A.S., gave a very thoughtfully prepared paper on The Sun's Journey Through Space and Distance from the Earth, at the close of which, by request, he recited Richter's Wild Dream.

The personality of the speaker awakened an enthusiasm which elicited words of praise and instructive and valuable remarks from Messrs. Hill, Scriven, Lee, Johnston, Morton, Woolverton and others.

FRIDAY, FEB. 28th, 1908

REGULAR MEETING.

President R. J. Hill in the chair. Four new names were submitted for membership.

After some important business items were disposed of, the President introduced the Rev. John Morton, former pastor of the First Congregational Church, who received a warm welcome and, after a few introductory remarks by way of explanation of his subject (Synthesis of the Natural and Supernatural), proceeded with his paper, the originality and thoughtful and instructive nature of which deeply impressed the audience. Messrs. Bertram, Alexander, Witton and others spoke words of praise and a vote of thanks was tendered.

FRIDAY, MARCH 13th, 1908

REGULAR MEETING.

President R. J. Hill in the chair. Two nominated for membership.

Norman L. Turner, M.A., Provincial Assayer, Belleville, in his illustrated lecture on The Petroleum Industry of Canada, gave a very lucid explanation of the geological sources and chemical nature of mineral oils with their commercial

development and the industrial application of the various products as obtained therefrom by science and invention. The young lecturer was highly praised by the leading members and received a very hearty vote of thanks.

FRIDAY, APRIL 10th, 1908

REGULAR MEETING.

President R. J. Hill in the chair. Five new members were nominated and previous nominations confirmed.

J. Davis Barnett, of Stratford, in his lecture on Coincidence, Luck and Chance, presented his reasons for believing that all the phenomena of life, both mental and physical, are dependent on some mysterious, hitherto unexplained law of coincidence. The lecturer received a very hearty vote of thanks.

THURSDAY, APRIL 23rd, 1908

REGULAR MEETING.

President R. J. Hill in the chair. Four members received.

C. H. Darrall, Engineer of Tests, Westinghouse Co., Hamilton. After giving full details of the progress of the Government tests in developing the process, the lecturer gave an analysis of each of the various modes of reduction with comparative results, showing the advantages in the quantity or quality of the finished products. Received a hearty vote of thanks.

THURSDAY, MAY 7th, 1908

REGULAR MEETING.

President R. J. Hill in the chair. Two members nominated and elected. Dr. Fletcher was chosen to be our representative at the meeting of the Royal Society at Ottawa.

Lyman Lee, B.A., after a few preliminary remarks, gave a well prepared paper on New Zealand. After a brief but graphic description of the physical conditions, the lecturer

gave an outline of the spiritual, social and political progress of the colony during British occupation. The many approving remarks which followed showed how highly his work was valued by his fellow members.

FRIDAY, MAY 22nd, 1908

SPECIAL MEETING.

President R. J. Hill in the chair. J. W. Tyrrell, C.E., in his lecture entitled "The Hudson Bay Route," carried his audience in his own inimitable way along the prospective line of future commercial development, which will soon give the Great West direct all-water access to the markets of the Mother Country.

THURSDAY, MAY 14th, 1908

ANNUAL MEETING.

President R. J. Hill in the chair.

Minutes of last meeting read and confirmed.

Report of the Council, by J. F. Ballard.

Report of the Treasurer, by P. L. Scriven.

Report of the Camera Section, by James Gadsby.

Report of the Astronomical Section, by G. Parry Jenkins.

Report of the Curator.

Report of the Geological Section.

Report of the Biological Section.

The following officers were elected for the ensuing year.

Honorary President—Adam Brown.

President—A. Alexander, F. Sc. S.

First Vice-President—H. B. Witton.

Second Vice-President—Matthew Leggatt.

Corresponding Secretary—G. Parry Jenkins, F.R.A.S.

Recording Secretary—J. F. Ballard.

Curator—Col. C. C. Grant.

Treasurer—P. L. Scriven.

Auditors—E. H. Darling, F. H. Wingham.

Council—J. M. Williams, Lyman Lee, B.A., James Gadsby, A. H. Baker, W. Delos Smith.

Report of Council.

Your Council take pleasure in submitting their report for the Session 1907–1908.

During this session there have been held six meetings of the Council, and eleven meetings of the General Association, arranged for as follows :

OPENING JUBILEE MEETING

in the Recital Hall of the Hamilton Conservatory of Music, November 8th, 1907,

at which the chief speakers were Hon. Adam Brown, H. B. Witton, Ex-M.P., A. T. Freed and President R. J. Hill.

ANCIENT ROMAN ART

Dr. G. W. Johnston, B.A., Ph.D., University College, Toronto, Dec. 13th, 1907.

ROMAN OCCUPATION OR BRITAIN

Prof. G. Oswald Smith, M.A., University College, Toronto, Jan. 17th, 1908.

THE SUN'S JOURNEY THROUGH SPACE AND DISTANCE FROM THE EARTH

G. Parry Jenkins, F.R.A.S.,

Feb. 14th, 1908.

SYNTHESIS OF THE NATURAL AND SUPERNATURAL

Rev. John Morton,

Feb. 28th, 1908.

THE PETROLEUM INDUSTRY OF CANADA

Norman L. Turner, M.A., Provincial Assayer, Belleville,
March 13th, 1908.

COINCIDENCE, LUCK AND CHANCE

J. Davis Barnett, Stratford,
April 10th, 1908.

REDUCTION OF ORES BY THE THERMO ELECTRIC PROCESS

C. H. Darrall, Engineer of Tests, Westinghouse Co., Hamilton.
April 23rd, 1908.

NEW ZEALAND

Lyman Lee, B.A.,
May 7th, 1908.

HUDSON BAY ROUTE

J. W. Tyrrell, C.E.,
May 22nd, 1908.

ANNUAL MEETING

May 14th, 1908.

We have the pleasure to record an addition of forty-three new members since our last report.

We have again chosen Dr. Fletcher, of Ottawa, to represent us at the meeting of the Royal Society in Ottawa on May 26th, 1908.

A large, double, upright case and a horizontal one have been added to our museum, and are already well-filled with specimens. We are glad to find that our esteemed Curator, Col. C. C. Grant, is again enabled to take an active part in the management of the museum. The cases have been rearranged and the accomodation much improved.

We are indebted to the Dominion Observatory of Ottawa for a very fine transparency of the moon, which now adorns our rooms. Another interesting donation, by Mrs. John Laing of Ancaster, is an old spinning wheel and reel brought from Scotland nearly a century ago.

It is with much pride that we record the successful celebration of our Jubilee Year by the issue of a special publication containing engravings of all our Past Presidents and Charter Members.

The museum has been regularly kept open to the public during the session, and it is gratifying to note that the number of visitors has much increased.

All of which is respectfully submitted,

R. J. Hill,
President.

J. F. BALLARD,
Recording Secretary.

The Roman Occupation of Britain.

Read before the Hamilton Scientific Association,
January 17th, 1908.

BY PROF. G. OSWALD SMITH, M.A.

To one coming to the New World the land of Britain teems with historical interest. As to the period of the Roman occupation of Britain, it is a period that can hardly be called a familiar one. Much of Roman influence in Britain has been lost, as in the case of some other nations. In France, Roman influence along certain lines has continued almost unbroken—bishoprics, for instance, were established in certain towns which at the time were of political importance. Those French bishoprics have remained to this day, but such is not the case altogether in Britain, although it is quite true that some of the English bishoprics are in places which were permanent in ancient times. Instances are continually occurring through which Roman influence can be traced in modern France, but in Britain, at the time of the English Conquest, they set out ruthlessly to destroy almost everything ; many cities were burned, and civilization had to begin anew on what has proved a better and securer foundation. Comparatively few traces of Roman towns have been left upon the surface. For a time it would seem that most of the cities of Roman Britain were abandoned, and altogether not much has been discerned as they had no large and conspicuous buildings as are still in existence in southern France, and doubtless the English climate has, in the course of ages, caused what remains there were, to undergo the process of decay. Britain as a Roman province possessed features that were common to the whole Roman system, as well as peculiarities of its own. We know that the Romans imposed their

form of government upon the inhabitants, and from Tacitus and others we have a fairly complete account of the history of Roman Britain, and also during recent excavations in the great wall of Hadrian more evidences have been brought to light, so that when we put together these various sources of information we should have no great difficulty in reconstructing the history of Roman Britain. We may first trace the events following the conquest. Let us remember the length of time of the duration of the Roman Empire. Gibbon's book, "The Decline and Fall of the Roman Empire," which has become so famous, is a little misleading because it gives the impression that great nations soon pass from the period of their greatest glory to their decline. On the contrary the Roman Empire declined very slowly—It will be well if the British Empire lasts as long as the Roman.

That Britain, which was held for upwards of 350 years, was one of the last provinces to be annexed by the Imperial Roman seems to be apparent. The remains found at Stonehenge were probably erected about 1000 B.C. by people who were displaced by the Celtic Britains, whom Caesar found on his first invasion. The story of Caius Julius Caesar's invasion commences about 55 B.C. He had been engaged in the work of annexing Gaul to the Roman Empire, and he crossed the Channel possibly because he desired to make new conquests. In this connection it must be remembered that the population of the south-eastern part of Britain was closely akin to that of Gaul, and they were not mere savages, but had reached an advanced stage of civilization, and there had been an emigration from Gaul to Britain a short time before. It was not, however, until nearly a century later that Rome acted further on Julius Caesar's plan. In 43 A.D. the Emperor Claudius finally decided upon the annexation of of the island. The plan was not a new one, as ever since Julius Caesar's visit to the island it had been under discus-

sion, and it had been urged that Britain, as an independent island, was too near the province of Gaul for their peace, and commercial considerations, too, proved that Britain was a country worth developing. So the Emperor Claudius sent an expedition to Britain under the command of Aulus Plautius, who crossed the Channel with four legions—the Second, the Ninth, the Fourteenth and the Twentieth. It seems probable that the Roman fleet directed its course to the Kentish cost and landed either at Dover or Richborough. Advancing through Kent they met with some resistance at the crossing of the Medway. Plautius penetrated further, but being overcome in the Essex marshes, where he lost a number of men, he sent for the Emperor Claudius, as he was instructed to do should reverses occur. Claudius set out from Rome with reinforcements and journeyed through Gaul to his assistance. After a few victories Claudius rerurned to Rome, and, leaving others to do the work, took unto himself all the honors. Some advances were made which are attested to by the fact that as early as A.D. 49 mines were worked. The Romans subdued the Isle of Wight, and from 47 to 52 A.D. built a line of forts along the Trent, thus securing the Midlands against north and south Wales. King Cunobelin had died between 42 and 43 and his kingdom was divided between his sons, Caractacus and Togodumnus. These princes were defeated by Plautius, and Togodumnus was killed and Caractacus was captured and sent to Rome. The period from 59 to 61 was marked by an advance in that district known as modern Norfolk. Seutonius Paulinus was attacking the island of Mona, or Anglesea, when Prasulagus, king of the Iceni, died, leaving his kingdom to be divided between his widow and two daughters and the Roman Caesar, but the Romans immediately began to act as though they had full possession. The Iceni were defeated with heavy loss, and to avoid disgrace Queen Boadicea poisoned herself. The whole affair was

really a plot on the part of the emperor to annex the whole of Britain, which shows Boadicea and Caractacus both to us as types of heroic though savage patriots. Boadicea was the mother of that race which was yet to be in Britain. Paulinus quickly reduced the island to order, but for some years after these events no advances of importance were made. The year 77 finally brought the people of south Wales to order. In A.D. 78 Julius Agricola was appointed to the command of the province. His tenure of service lasted eight years, and was marked by a rapid civilization in south and central Britain. Agricola successfully attempted to complete the conquest of the island of Mona, which had been begun by Paulinus. He then pushed boldly forward against the Caledonians in the far north, eventually defeating them in a great battle among the Grampian Hills. While advancing, he was careful to secure the country through which he passed, and with him the work of the conquest may be said to be very complete, though the country was hardly settled, but the work of consolidation now began and continued for several years.

In A.D. 120, the Emperor Hadrian, in the course of his journeyings through the provinces of the Roman Empire, reached Britain and and advised the building of the wall between the Solway and the Tyne. In speaking of this wall of Hadrian's ; it was not a mere frontier barrier against the country to the north of it, but it was only part of a large system of fortifications to the south of it. Parallel to its entire length ran a trench, while between, was the wall with mile-castles built at intervals of about one Roman mile, and buildings for the troops. The first object in constructing Roman roads throughout Britain was the marching of troops and the conveyance of stores, as well as for the private citizens who could afford it. There were four principle lines of roads : Watling Street, which runs from London to Wroxeter ; the Fosse Way, connecting the sea-coast in Devonshire with Lincoln ; the

Ickneild Way, commencing near Bury St. Edmunds in Suffolk and running to Gloucester; and Exning Street, which ran through the marshy district of the east of England. About 140 the Caledonians again gave trouble. Shortly after that, about the middle of the second century, the earth-works between the Firth of Forth and the Firth of Clyde were constructed, and these were more in the nature of a frontier limit. The Romans now finally abandoned the idea of conquering the whole island. We come now to the reign of Arcadius. One, Carausius, was put in charge, but instead of keeping to the business before him he took advantage to set up for himself, and secured the allegiance of the Britains from 287 to 293. By 297 Britain was restored to the Empire, and the Emperor Constantius spent much of his time in Britain until his death at York in 306. He was succeeded by Constantine the Great, whose mother was a Briton, and who began his victorious and successful career in the island of Britain. During the remainder of the fourth century Rome was slowly losing her hold. In frequent conflicts ground was lost, and merely gained only to be lost again. Rudyard Kipling in one of his books has a wonderful account of that last struggle. In 410 Honorius wrote a letter to the cities of Britain in which he commanded them to defend themselves. Then began the long drawn out agony of the English conquest. Roman rule in Britain was held by the sword. This was especially the case in the north and west—three legions were permanently placed in the island. The Twentieth legion had its headquarters at Chester; the Second legion at Richborough, and the Sixth legion, which replaced the Ninth, which was nearly annihilated in the outbreak among the Iceni, was stationed at York. Numerous legendary stones have been discovered showing that all three legions, or detachments of them, were employed in the construction of Hadrian's wall. We also find records showing that foreigners of many nations must

have served in Britain, for when Rome conquered a nation she drew reinforcements from the conquered for fresh conquests. As this system prevailed in all the Roman provinces, Britons often served in foreign lands under Roman rule. There was a strongly fortified bridge over the river Tyne, traces of the abutments and piers of which can still be seen. A fragment of the earth-works, which ran parallel to the great wall at a distance of from one hundred yards to half a mile, is still visible, and also part of the wall which has perished more from the hands of man than from nature, as the stones of which it is constructed are being gradually carried away by the farmers in that district for building purposes. We have to use our historical imagination somewhat in constructing a Roman camp. The forum stood in the centre of the city forming nearly a perfect square, and the basilica, or court-house, with the curia or council-chamber on the west side, and on each side of these were halls or rooms for conducting business. An outer walk ran around the whole space occupied by the forum and basilica. Within this were a succession of offices connected with the forum, and in front of these an inner walk. City life centred around the forum, basilica, public baths and temples. Every city in the Roman Empire was constructed upon the same plan, viz., with the public buildings in the centre. Some of the Roman towns were London, Silchester, Chichester, Chester, Colchester, Lincoln and Bath, which are in themselves a further proof of Roman manners and influence long surviving because they have retained the Latinised names of still earlier forms. The excavations at Bath have led to the knowledge of the construction and arrangement of Roman baths for health and luxury. It is doubtful if Bath was ever a place of military importance, but rather a health resort, and as such it has continued from the second century to the present day. In many cases the walls surrounding the towns were added at a later date for

additional protection. No doubt the houses had a fairly large number of rooms, in some cases they had two sets of apartments, for summer and winter respectively. The floors of the rooms were often handsomely decorated with well blended mosaics, no doubt they resembled those found at Pompeii. Many very beautiful patterns have been found at Silchester, Woodchester and the Isle of Wight. There are traces of extensive iron works in Gloucestershire and Herefordshire, also mines of tin, lead and copper in Somersetshire, Northumberland, Worcestershire and Essex.

The importance of religion is very apparent. The worship of Caesar was regarded politically as the bond of imperial unity. The Romans were very, very tolerant of the different forms of religion. The reason that Christianity came into conflict with the Romans was that they would not pay tribute to the Roman Emperor. While Druidism as an institution had died out some time before, it would seem that some local worship remained, and there were other forms of worship—the worship of gods and goddesses, and the mysticism of the eastern religion—a kind of purified sun-worship which took its origin in Persia, it really proved a rival to Christianity. Christianity was probably introduced from France or Gaul during the third century. The official class was the very last to accept Christianity. Distinctly Christian symbols have been found inscribed on tablets in churches, and sometimes in the stone work of buildings. Remains of Roman-British Christianity are supposed to be seen in the bricks built into St. Martin's Church, Canterbury, also in a church at Dover, and again at Brixworth. In all probability the early civilization showed considerable material prosperity and a fairly high level of culture and refinement, but Britain never reached the level of some of the other Roman provinces.

Views illustrating Roman life and influence in Britain were thrown upon the canvas at appropriate intervals. Some of them were as follows :

Remains of Roman gates and walls.

Remains of Roman baths.

Remains of Roman wall and camp.

Roman tesselated floors (restored).

Maps showing Roman roads.

A bronze Roman eagle found at Chichester.

Two views of cliffs of Dover showing Roman lighthouse.

Roman ruins at Pevensey.

Picture of a Roman standard-bearer represented as riding triumphantly over the body of an unfortunate Briton.

The Sun's Journey Through Space and Distance From the Earth.

Read before the Hamilton Scientific Association, February 14th, 1908,

BY G. PARRY JENKINS, F.R.A.S.

A French philosopher said, "when you are right you are more right than you think," and nowhere is this profound truth more forcibly illustrated than in astronomical investigations. It has now been proved without doubt that all the stars are endowed with proper motion. There appears to be no such thing in fact as absolute rest among any one of the myriad of bodies that compose the host of heaven. Each moves in an orbit, the path of which is influenced by the universal power of gravitation, which we find reigns supreme, not only through the solar system, but to the infinitely greater stellar universe beyond. Circles, ellipses, parabolas and hyperbolas, in fact every one of the conic sections, all enter into the paths of some of the mighty orbs around us. What complexity of motion is here indicated by the side of which the most complicated machinery of man's invention are mere playthings. When Copernicus, the founder of the present system of astronomy, overthrew the older conception of the earth being the centre of the solar system and placed our sun as the true pivot around which the earth and all the other planets revolved, he considered the sun to be stationery. However, the human intellect was gradually enabled to separate the real from the apparent celestial motions. Then when the great truth dawned that the stars were suns and the sun only a star, and it was found that many of them were possessed of real motion, the question naturally arose whether according to the law of analogy the great central

sun of our system was not also moving in space like the rest of the stars, or whether it was an exception to the universal rule.

Here is, therefore, another grand problem presented for solution by astronomy and worthy of the highest effort to unravel its mysteries, whither are we going? Because if the sun is moving, the earth and all the planets of our little system are being drawn along with it. In embarking on a journey we invariably desire to know where we are bound for. In this particular case, however, we have absolutely no choice in the selection of our travel, but constituted as we are, it is some satisfaction to endeavor to find out the far distant goal our sun is carrying us to.

It cannot be too clearly pointed out that the journey we are now contemplating has nothing whatever to do with the earth's annual journey around the sun—which constitutes our year. It is the far greater orbital movement of the sun making up, in fact, its year, as we are accustomed to reckon time, that we have to do at present. We know that once every year our earth performs a circle within another vast circle, the circumference of which is occupied by the sun and which is the one we are now considering. The last circle is so wide that even in travelling a segment of it the sun appears to be moving in a straight line, and no deviation whatever has yet been observed during the short time man has been enabled to make observations, as the sun's path through space evidently requires many centuries to assume any other than a tangential motion.

To help us to understand this real movement of the sun among the stars, let us compare the effect of distant objects upon our senses as we approach them on the earth. In walking through a forest, for instance, the trees in front of our path appear quite close together as seen a long way off, but as we approach nearer to them they spread out until as we pass them they are actually on either side of

us, and then as we move on the same trees appear to come together again from behind. Whichever way we turn our steps the same effects are invariably observed among the trees. So too with all other objects as we approach and recede from them. The same effect has often been strikingly exemplified in our own experience at sea by night. In making port two harbour lights are usually placed on the pier. At a considerable distance out these lights have apparently almost touched one another, but as the good ship ploughed her way through the deep and came nearer shore, the welcome beams spread further and further apart until they appeared at last on our port and starboard sides. Then, as the vessel proceeded up the harbour, the same lights appeared to gradually close up again.

In order to determine the course of the sun's voyage through space, it will now be apparent that no evidence of this motion can ever be obtained by observations of the sun itself, nor, in fact, of any movement of the earth, moon or planets, as they all travel together in a body. It is only by endeavoring to find out if any such effect as we noticed in the forest or on sea is observable when we look right out into space at the far off stars, which do not partake of any motion attributable to our sun, that we can ever hope to find the secret of our destination, or what, in technical language, is known as the "apex" of the sun's way.

It was the genius of Sir Wm. Herschel which first applied this reasoning to determine the point. By classifying the proper motion of all the stars as known to him in 1783, he found conclusive evidence of the direction of the sun's path as well as its velocity. The principle involved is thus defined by Prof. Young: "On the whole, the stars appear to drift bodily in a direction opposite to the sun's real motion. Those in that quarter of the sky which we are approaching open out from each other, and those

in the rear close up behind us. The motions of the individual stars lie in all possible directions, but when we deal with them by thousands, the individual is lost in the general and the prevailing drift appears.''

The exact spot in the heavens to which the solar system is moving, according to the elder Herschel, is situated in Right Ascension 260° 34′ North Polar Distance 63° 43′. This is found to be situated in the constellation of Herculis and close to a star of the 4th magnitude, known as Lambda Herculis. The more recent researches of such illustrious astronomers as Argelander, Madler, Struve, Airy, Dunkin and others all agree in placing the direction of the solar motion very near to this point. A totally independent confirmation has also been given to the above conclusions from spectroscopic observations by Sir William Huggins. If there was some excuse for one of Shakespeare's characters to say three hundred years ago:

> "Doubt thou the stars are fire;
> Doubt that the sun doth move,"

the revelations of modern science has swept away the clouds of uncertainty in the matter.

After sifting all the intricate movements which produce what is known as star drift, it is possible to put our finger with certainty upon so much of it which belongs entirely to the speed of the sun. According to such high authority as Sir Robert Ball, "every two days the solar system accomplishes a stage of about a million miles in its journey towards the constellation of Herculis."

We have now reached that stage in our consideration of solar motion which opens up the question whether there is a central sun around which our own sun and others are revolving. Let us say at once that here we are treading on very uncertain ground, although the probabilities are all in favor of such an arrangement from the present knowledge we possess of the plan upon which the universe has been built. The celebrated German astronomer,

Madler, announced to the world in 1846, it was his conviction that our sun and planets were revolving round a great central sun. This he made out to be Alcyone, the central star in the familiar cluster called the Pleiades, and he computed it took 150,000,000 years to complete a single revolution. This theory has been revived on several occasions in later years, and many fanciful ideas as to this star being the ultimate abode of bliss has been advanced, but at present the least we can say regarding it is summed up in the old Scotch verdict, "not proven."

If the ancient Assyrian star-gazers had only been able to hand down to us accurate charts of the constellations as known in their days, our way would have been made much clearer. Fortunately, at the present day, accurate maps of the stars are in existence which will serve as a basis for future generations to note the changes taking place on the face of the sky, and such a problem as now confronts us will undoubtedly be solved in course of time. Especial mention must be made of the stupendous astrographic survey and photographic map of the entire heavens which was undertaken in the year 1887 by eighteen of the principal observatories in different parts of the globe, and which work is at present nearing completion. No less than 20,000 plates have been exposed in this epoch making work. When the whole chart is published it will remain a permanent record of the exact position of the stars at the close of the nineteenth century. We can safely prophesy that a careful study of this great undertaking by astronomers, centuries hence will yield up some of the profoundest secrets of the stars which are at present so jealously guarded by dame nature.

The determination of the sun's distance may be regarded as the laying of the foundation stone upon which the whole fabric of astronomical science is built, and upon which it is possible for its pinnacle to be reared to the very heavens above. Without this knowledge of how far

away the sun is from us, it would have been absolutely impossible to tell the distance that separates us from any of the millions of other worlds around us. We would forever have remained in ignorance of their mass, which quantity enables us to tell at present the very influence they exert over their neighbors in space. If the sun's distance had not been ascertained, it would have been impossible for us tc tell its true size, neither could we have determined its weight or density. Moreover, without being aware of the sun's distance our knowledge also of the distance, magnitude and weight of all the planets would have remained forever unattainable. It is therefore at once apparent how supremely important in all astronomical questions is this unit of measurement of space—the distance between the earth and the sun. There is little wonder then that some of the greatest minds that ever lived, from Aristarchus of Samos, who flourished before the Christian era, down to the present day, have devoted their whole talent and skill in endeavoring to solve, with the least possible error, this grand problem of the sun's distance.

It is easy to tell the distance between two points on the ground if we can put our chain measure across. The case, however, is very different when we attempt to measure any inaccessible object when a river or other obstacle bars our way. Here we have recourse to the method adopted by the land surveyors who, by means of an instrument for measuring angles and known as the theodolite, can tell the distance an object is away in yards or feet with the same degree of accuracy as if they had been able to carry their chain measure accross the river, for instance. This method depends upon certain well-known properties of the triangle and fully described in works on trigonometry from which it follows, if we know the length of one side and two angles of any triangle, we can then always calculate with certainty the other angle

together with the length of the remaining two sides. In order to find out the distance of any object it is not necessary to advance a single step towards it, but it is essential to step aside to produce what is known as a base-line sufficiently long to make the object appear to shift its relative position, otherwise we cannot form a triangle with its apex at the point to be measured and the other ends resting on either side of the base-line, and the whole success of our undertaking rests upon this. Once these three points are within the meshes of a triangle, the space readily yields up its distance be it ever so remote.

If the object is near, a very short base-line will suffice to produce a change of position or parallax, as astronomers call it, and the further the object is removed the longer must we travel in an opposite direction before any alteration is apparent. In fact, two lines drawn from opposite sides of the earth and meeting at the centre of the sun would make no appreciable angle and only appear as parallel lines. The extreme difficulty of the problem encountered in finding the sun's distance may be realized from the conditions being identical to a surveyor with a base-line of five feet being required to tell the distance of an object ten miles away. In the case of our nearest celestial neighbor, the moon, its distance is comparatively so close to us that an observer in Hamilton and another in South America will see it at the same moment of time, projected in different parts of the sky, from which cause its real distance of 238,000 miles is easily calculated ; but if the sun is viewed from even the two extreme ends of our globe, its position in the heavens remains absolutely unchanged. Accordingly in attempting to measure the enormous distance of the sun astronomers have to resort to one or other of three different methods which we will briefly consider.

The principal method in the past has been to determine the distance of Mars and Venus, the two nearest planets

to us, and from these results the solar parallax has been indirectly worked out. This is known as the trigonometrical method. It should be remembered that if only the distance between any two planets is found, the distance of all the others follows as a natural consequence of the discovery of Kepler's great law, that : "The squares of the periodic times are proportional to the cubes of the mean distances." The task, therefore, is only to find out the scale upon which the solar system has been formed, as the relative position of every member is already very accurately known.

As early as the year 1670 the French Academy of Science sent out an expedition to Cayenne to take trigonometrical measures of Mars in order to compare with those made in France, but the results were not very conclusive owing to the inferior instruments then in use. Little better results were obtained in 1752 at the Cape of Good Hope by Lacaille, who fixed the sun's parallax at 10″, from which the sun's distance would be 82,000,000 miles, an amount we know to be very far out.

As Mars is particularly well placed, every fifteen years, to make such observations on account of its close proximity to the earth, full advantage has been taken of such periods. Owing to the favorable conditions of the year 1857 in particular, Dr. Gill succeeded in obtaining excellent measurements of Mars in Ascension Island, and deduced 8.780″ as the sun's parallax, corresponding to a distance of nearly 93,000,00c miles. Of recent years some of the minor planets, which revolve between Mars and Jupiter, have been utilized to arrive at the true distance of the sun, and many astronomers are of opinion the most satisfactory results of all are to be obtained by a careful examination of these tiny worlds, invisible though they are to the naked eye.

The rare astronomical event, known as the transit of Venus, is associated with some of the most noted attempts

ever made to measure the sun's distance. It occasionly happens that Venus is situated exactly between us and the sun, and appears to move across the solar disc as a round black spot. This phenomenon is called a transit of Venus, and is visible at most twice in a life-time. These remarkable events take place at regular intervals of 8 years, 105½ years, 8 years and 121½ years respectively, and they always happen during June and December. We thus find there was a transit of Venus in June, 1761, followed by one 8 years later in June, 1769. Another did not happen for 105½ years, being in December, 1874, while the last took place 8 years afterward in December, 1882. Then follows a great gap of 121½ years, as not a transit of Venus will occur until June, 2004, to be succeeded by another in June, 2012, and so on.

It became certain to Halley in the year 1716 that advantage might be taken of these occurrences to determine the distance of the sun, and knowing that he could not possibly live until 1761, the date of the next transit, in order to verify his conclusions, he bequeathed the grand problem of finding the sun's distance by this method to posterity. Enough has been said to comprehend that as viewed from two widely separated stations on the earth, Venus appears at such times to travel over the sun in different parallels of latitude, so to speak, owing to the effects of displacement caused by the postion of the observers; hence the problem here is to note the exact time the planet takes to transit the solar disc as seen from two stations whose distance is already known. The angular diameter or apparent size of the sun being easy to measure each day the sun shines, it becomes possible, during a transit, to calculate the angular distance between the two observed paths of Venus as it moves across the sun. This minute quantity bears a certain proportion to the whole diameter of the sun which, on being worked out, yields the solar parallax and is, in other words, the angle

which the semi-diameter or radius of the earth would subtend as viewed from the centre of the sun. Once this exact amount is found we have all the data required to calculate with precision the distance between the earth and the sun.

Although elaborate arrangements were made to observe the transit of 1761 in different places, unfortunately cloudy weather and other circumstances practically defeated the first attempt. The transit of 1769 created more enthusiasm and with it came a greater determination to succeed. Special expeditions were accordingly sent out by the governments of various European countries to witness the event. It was in this year that the famous Captain James Cook, the first man to sail around the world, was sent to Otaheite in the Pacific Islands to observe the transit of Venus, and a party of astronomers from Greenwich were located at Fort Prince of Wales, Hudson Bay, while many observers were stationed in remote parts of the globe. After an exhaustive examination of all the available results of these two great events, Prof. Encke, of comet fame, determined the solar parallax to be 8.5776″, which gave 95,300,000 as the sun's distance. This amount was accepted for many years and became embodied in all works on astronomy, but doubts as to its absolute accuracy were raised in 1854 by the evidence of a new method based upon gravitational principles, which we will refer to later on.

No one will wonder at these discrepancies who realizes the infinitesimally small quantities astronomers have to deal with in computations of this kind. A hair-breadth of difference in observation will throw out the result by many thousand miles in actual measurements, and this fact only emphasizes the conclusion that, however perfect this theory may be, yet in practice it taxes human ingenuity and refinement to its fullest capacity. Lest any of you should be tempted to say, after listening to my remarks, like Mr.

Gilbert's Ferdinando said on another occasion, "we know it's very clever, but we do not understand it," let us endeavor to convey a clear impression of this minute angular value of the solar parallax, amounting to less than nine seconds of arc, and to determine which astronomers have spent so many years of diligent research aided by every known optical device. How much, then, does a second of arc represent? Of course the unaided eye is totally incapable of estimating it. Prof. Pritchard, whose researches on stellar parallax have made him famous, says: "It will convey but little idea if we say it is the 324-thousandth of a right angle, for the very numbers confuse the mind. But what then is a second? It is equivalent to the angle subtended by a ring one inch in diameter, viewed at the distance of three miles and a third. The correction to be made to the sun's parallax is just one-third of this; that is to say, it is the error which a rifleman would make who shot at the right-hand edge of a sovereign placed twelve miles off, and who hit it by mischance just on the left edge! It is what a human hair would appear to be, if viewed at the distance of over 150 feet!"

Yet we know the distance of the sun far within the limits of the proportion above indicated, and if the second of arc is such a small quantity, what then must be the labours of our astronomers who deal with a sub-division again of the second referred to, into one hundred parts, each of which division represents 100,000 miles in the determination of the sun's distance.

The last two transits of 1874 and 1882 were very successfully observed by astronomers of every nationality, and aided by photography, which played such an important part on these occasions, the results have confirmed the fact that the sun's parallax was smaller than hitherto established. From a combination of the results of both transits, Prof. Newcombe deduces a parallax of 8.776″ corresponding to 92,350,000 miles.

Two other extremely delicate methods of finding the sun's distance are reserved for the mathematician, both of which are based upon the subtle attraction of gravitation. The first is called the lunar method of finding the sun's parallax, which depends upon the ratio between the diameter of the moon's orbit and the distance of the sun. It was this method that led Hansen in 1854 to throw doubt upon the generally accepted value of the sun's distance of those days. The other method, founded upon the same influence exerted by gravitation, enables the astronomer, by observing the perturbations of the planets, to compute the ratio between the masses and distance of the whole solar family.

There still remains one other method of solving the problem we are dealing with, and it is known as the physical method, by which the velocity of light is made to disclose the distance separating the earth from the sun. Light travels at a speed of 186,327 miles a second, and we have only to multiply these figures by the number of seconds required by light to reach us from the sun to get at its distance. After combining all the results of this last method, which Prof. Young says outranks all others, as it gives directly the distance of the sun and the parallax only indirectly, he obtains 8.80″ as the solar parallax, giving a final distance of 92,892,000 miles. We may therefore rest assured that for all practical purposes 93,000,000 miles is the limit we can obtain at present, and that, at last, we hold securely in our hands the key which unlocks the mysteries of the stars around us.

Synthesis of the Natural and the Supernatural.

BY THE REV. JOHN MORTON,
HAMILTON, ONT.

Read before the Hamilton Scientific Association, February 28th, 1908.

There are many signs that the long and sometimes bitter war between the representatives of the natural on the one hand, and of the supernatural on the other, is coming to an end. There is a growing conviction, among the leaders on both sides, that they stand respectively, not for contradictory, but for complementary aspects of the life of the world and man. My purpose is to call your attention to some of the signs of conciliation and to indicate the point of view from which both aspects are seen by the thoughtful man, to be parts of the larger whole. I cannot indeed, in addressing a meeting of the members and friends of a Scientific Association, forget that some of you may still wince at the word supernatural. To your ears it does not sing in tune with the word natural. But I would venture to bespeak your consideration for it, even though for a number of decades it has fallen into disrepute, and been boycotted by those whose eyes have been opened to the order of nature. The word, I would remind you, is itself a child of nature, and the student of nature is bound in honor to account for its genesis in experience, and its potency in history ; for the larger science knows that a word, whose battle cry has been heard in every age, has its roots in reality. Thus the student of nature cannot escape supernatural experience. Even in his personal experience it faces him the moment he begins to reflect. The stretch-

ing out of the hand to give a cup of cold water in the name of humanity is a natural act, but I venture to say that it has never yet been fully explained on the principles of pure physics. But he meets supernatural experience in every page of the history of humanity. Religion is natural to man ; and I here mean by religion not merely the church, its order of service and sacraments, though these also are facts. I mean the experience and the idea of the supra-sensible which has created and which preserves in life all these. It is an idea, as the science of anthropology has made clear, which is essential in man. "It comes into being," says A. M. Fairbairn, of Mansfield College, Oxford, "without any man willing it, and as it began so it continues. In the hour of revolt individual men may have nothing to do with it, but instinct is stronger than will, and religion in some form both of idea and usage returns, be it as the memory of a dead woman as with Mill or Compte, or as an abstraction of Humanity loved of the positivist, or of the unconscious, adored by the pessimist, or as the unknown worshipped by the awe of the Agnostic." Religion, which is supernaturalism at its highest, is thus natural to man. Consequently the student of nature cannot escape supernatural experience except by excluding from his scrutiny human nature. Nor has he sought to close his eyes to it. As a matter of fact every distinguished man of science has dealt with supernatural phenomena, and the same may be said of every thoughtful man. Their treatment is varied and often contradictory. Some thinkers conclude that there is a supernatural realm, but that it is, in its nature, beyond our knowledge, and that therefore it is the part of wisdom not to waste time upon it. Others have held that the idea of the supernatural is a fiction which has arisen from a superficial view of experience. It is, however, beyond question that the great majority of thoughtful men, whether distinguished or unknown, think and feel that there is something in the life of the world and

man which answers to the word supernatural. It is true indeed, that, like every other fact of experience, it has been misunderstood and misrepresented, but we may rest assured that it could not have held its grip on mankind in all ages unless there had been, beneath its mistaken forms, a root of reason. It has a fascination for all, and it is the impulse of the larger science to find its place in the unity of existence.

I.

The quickened consciousness of the unity, underlying and manifesting itself in all forms of life, is in evidence everywhere. Intellectually it takes shape in an unresting quest for "a monism, which constitutes and develops undisintegrated by freedom or the aloofness of nature." And the success of the quest is seen in the fact that, amid the increasing complexity of life, the signs of its unity become more than ever apparent. To begin at home, in our own country there are many races and creeds with innumerable conflicting interests, but a common ideal is drawing them together. The same essential unity is seen in the classes and the masses; for though their interests are becoming no less, but ever more diversified, they are learning from the discipline of the nature of things that they are all members of one body, and that no one member can say to another, "I have no need of thee." And in like manner the religious life and the secular life, the church and the world, the supernatural and the natural are coming to be seen as different aspects of man's complex existence. This reconciling spirit is felt by every one; and it is known and deliberately cherished by those who have been able to see, not only the ripples of the river, but the direction of its course.

II.

The growth of a better understanding between the representatives of science and religion is known to us all.

They are not now two camps: they are one. In the past, it is true, the feud between these two provinces of knowledge was bitter. Supernaturalism, in generations gone by, has been far from friendly to students of nature. There is, I believe, a suggestion of this bygone distrust in an unwritten rule of this Association. It is in the form of an understanding that supernatural questions should be excluded from our discussions. Such an understanding suggests a time when the supernatualist was felt to be a disturber in a gathering of students of nature. And as a matter of fact he was. He stood aloof from the student of nature, looked upon him not only as an enemy of God, but of society, and took the stern measures of those days to suppress him. Let one instance suffice to bring home to us the uncompromising character of the enmity. On the seventeenth of February, 408 years ago, Giordano Bruno, an enthusiast in science, was burnt alive on the Campo di Fiora, in Rome, because of his discoveries in science; the "head and front of his offending" being his belief in what was called, by his accuser, the abominable and absurd doctrine of innumerable worlds and the rotatory motion of our planet. And this was no exceptional instance of the means taken to prevent the scientist from prying too closely into the secrets of nature. Let us not, however, be unjust to these old time representatives of the supernatural. They were men of their day. They had a zeal for God, "but not according to knowledge," and some of them, at least, carried through these terrible deeds against their own instincts of human sympathy, in obedience to their consciences. Let us be thankful that we live under happier skies. There is a more enlightened conscience in Italy to-day. There, on the same Campo, eight years ago, on the anniversary of Bruno's martyrdom, a monument was erected to his honor on the very spot where he paid the price of enthusiasm for the truth of nature. And thus once more, "wisdom is justified of her children." And this

bitter feeling of the friends of religion to science is seen in any direction we like to turn in the world of education. It is very manifest in our theological colleges. They call to their consideration of life and the world not only students of the Bible, but also students of science. They thus manifest the growing consciousness that supernatural teaching, which stops short of the knowledge of the world in which we live, is mischievous—the possession of fire without the knowledge of how to use it. "Two things are necessary in order to attain any end," said Principal John Caird at a social science congress in Glasgow, "the desire or disposition to achieve it, and the knowledge how to accomplish it. It is the function of religion to stimulate the former; but that achieved, in order to any wide or lasting result, it must call in the aid of intelligence, of science, of the knowledge of human nature and human society, to which only the most careful observation can attain, and without which all fervor of religious zeal will be comparatively useless—sometimes even dangerous and noxious." This, uttered more than thirty years ago, is a striking expression of the conviction which has come home to this generation that religion and science must work together in the creation of the "new heaven and the new earth."

III.

But it is important to note that this alliance is between a purified supernaturalism and an open-minded science. No doubt the word supernatural is still to many suggestive of its old superstitious associations. We are shy of it. It carries with it, in addition to its essential truth, suggestions of the uncanny and the unnatural: invisible persons, not in nature, but outside of it, and intruding into it in ghostly fashion, sometimes for good and sometimes for evil. Like many other words it needs to be born again. It needs to have a rational soul breathed into it. Thus it

will be transformed, and, when we hear it spoken, it will suggest to us a Power which is as native to nature as reason is to man. It will suggest to us the Power whose activity is the creative energy of nature's process, and whose laws are identical with the laws of nature. The word, so regenerated, will quicken within us the root of reason, which has given it a central and potent place in the mind, life, and speech of mankind. Every word, which has had a long life, has roots struck down deep into the soil of reality, however rotten many of its branches may have been. Alchemy pointed to chemistry. Astrology held on its way till it cast off its garments of darkness and put on its trailing robes of harmony and light. And in the same manner science and philosophy are gradually unfolding to us the truth that, in human existence, there is no supernatural without the natural, and no natural without the supernatural. Carlyle saw this when he flashed from his forge the glowing chapter, in Sartor Resartus, on Natural Supernaturalism.

Science has done much during the last three hundred years to bring a sane look into the eyes of the supernaturalism of the middle ages. Up till the 15th century, Lecky tells us, "a miraculous narrative was universally accepted as perfectly credible, probable and ordinary." And witchcraft was in those days as live an issue as tubercular bacilli in Canada to-day. The dread of it was on the learned as well as the common people, the Christian as well as the pagan, the reformed as well as unreformed church. To stamp it out, as I have said, the government and the church united in terrible measures. Now all this supernaturalism, divorced from the knowledge of nature, has passed away, or is passing. It has come about, through movements of thought, to which I shall refer in a moment, that, when the word is used by intelligent men, it no longer stands for tricksy spirits of the air which bewitch the milk in the churn, blight the crops and turn all things

awry. It means a Power immanent in nature and yet above it, which seems to see the end from the beginning, and to be the identical Creative Energy at every stage of the evolving process. Thus we have entered an age in which the supernatural, in the world and in the progressive life of man, is not looked upon as something unnatural, but rather as the very *nature* of nature. And hence the modern supernaturalist wants to know the nature of things. He does not, as did the supernaturalist of olden days, burn a Tyndall or a Spencer. He builds a college for him that he may have the opportunity of studying nature and of enriching life by the knowledge of it. In the words of Caird he calls in the aid of "science and the knowledge of human nature and human society" so that his supernaturalism will be neither noxious nor dangerous, but the rich soil out of which springs up all that is healthy in nature and holy in human life.

Such is the friendly attitude of the new supernaturalism to science. And the representatives of science have reciprocated these friendly approaches. They are more willing to admit, than they were in the middle of last century, that there are elements in experience which are not amenable to their chronometer or measuring line. They can measure and number the notes of a master-piece of song, but when they come under its spell, they are lifted up into an element which knows no vibrations, and of which, if they would speak at all, they must, like Tennyson, take up their parable and say, "the tide of music's golden sea is setting toward eternity." So in art. They can measure the height and angle of the spire which they see against the sky, but they know that their instrument is helpless when they try it on the boundless space in which the spire is individualized. They know also that when they have made a methodical map of the movements of nature—and their success here treads on the heels of the supernatural—they have still to account for the Energy

which is the creative cause of harmonious movements. Tyndall, some forty years ago, in his famous address at Belfast, inspired by the far shining light of evolution, was carried on to say, in words which became historic, "there is in matter the promise and potency of all terrestrial life." But even he, when pressed by Martineau to define his terms, took refuge in the phrase, "those *mysterious* things called atoms," thereby revealing his sense of an Energy whose ways or laws are known to science, but whose intrinsic nature is too fine to be touched by the instruments of science. And this consciousness, in the years since then, has become more distinct in the minds of men of science. They see that, within and beyond the evolutionary process, there is the evolutionary cause, and that the latter is expressing itself through the former. Thus the representatives of a purified supernaturalism and an open-minded science are agreed that their respective spheres of study are two aspects of existence as a whole, that the one is never apart from the other, and that each can be understood only through the other. They are agreed also in the view that what we call the supernatural is to be known through our experience of it in the sky, the mountain, the valley, the river and ocean, and through the history of man—in a word, through the whole volume of nature, taking the word in the largest sense as inclusive of all experience. And, on the other hand, they are seeing that the natural cannot be known if we confine our attention to physical processes and leave out of account those experiences which cannot be classified on the dead level of the physical.

IV.

This happy *reapproachment* between an intelligent supernaturalism, and a science hospitable to all truth, has been greatly furthered, strange to say, by the doctrine of evolution. This hypothesis has supplied a point of view

from which the two apparently contradictory sides of existence are seen to be intrinsically one. When it came home to us that the progressive development of the life of the world and man is organic, it became clear that there is, in spite of appearances to the contrary, no schism in the body. Every member shares the common life. "In the production of this needle, with which I prick this blister in the palm of my hand, the whole universe took part," said a young student of science while he rested on the golf grounds and chatted to his companion. In this new view we see that life is more truly described as a growth than as a building. True this view is not, in the strictest sense, new. It is new only in the sense that we are becoming more conscious of it. It has been dimly present in all the great theories of human existence, for though in actual life man has always been distracted by the clashing currents of experience, there never has been absent from him the half-born feeling that these interacting forces have their being in one Element. But in this generation the feeling has become articulate. From the day we enter school to the day we leave it, and in all our studies afterward we are looking at things in the light of the idea that things hang together and that what is now is the fruit of the past and the seed of the future. Let us therefore bring this view of life before us, and try to discover, in the light of it, the principle of unity in and through which the apparently contradictory individuals, while retaining their individuality, advance to a single goal. (*a*) Regarding man's development as revealed in history, Edward Caird, late Master of Balliol, Oxford, says, "there is no idea which is so potent in our day as the idea of evolution, development, or organic growth. The favorite method of finding out what anything is, or at least what any living thing is, is to ask how it came to be, to read its present state in the light of its past, and to trace out the various steps of change that link the form it has attained with the

earliest manifestations of life. Whether it be a plant, or an animal, or a man, or a society of men, or even the human race as a whole, we never think we know it thoroughly till we have seen it in its whole history as a gradual process, whereby without haste and without rest it has changed from less to more, yet preserving through all the revolutions of its being the characteristic quality or tendency which distinguishes it from all other creatures in the universe." This view of life "carries us beyond the superficial view of former days when we looked on history as a chronicle of stirring events, and wonderful, but incomprehensible revolutions of fortune." This new knowledge of life makes clear to us also that "the 'child is father to the man,' and that from boyhood to manhood and from manhood to old age we detect the same individual nature, and link each individual speech with that which preceded it. In like manner we have come fo look on history, not as a play of chance and arbitrary will, but as the development of one natural character through many vissitudes which test and try, but never break the thread of connection with the past, or prevent us from seeing that they are all the same life." (*b*) But the invisible, yet real, thread of connection, which connects the human life of any particular age with human life of all preceding ages, revealing to us that they are the same life, goes farther back. It binds the life of man with the life of the world in which he lives. Away back at the beginning of things, as science, by its hypothesis of evolution, is making clear, the creative Energy which, while more than nature, dwells in nature, gathered together her innumerable host of atomic workmen and formed, so to speak, the first labor union. After years and years of organized and organizing labor, she turned out as Keble, I think, says, this "green globe which floats through space" and on an arc of which we Canadians have our home and heritage. And she has done more than this for us. She has created conditions in

which we, in alliance with her, can carry on our national undertakings for the benefit of our people, and through them for the good of the world. By her marvelous contributions of water, descending valley and gravity, she has given us the noble river St. Lawrence. By an age-long and patient process of growing and decaying prairie grass, she has made it possible to feed the world with the finest of the wheat. By her cataracts, which blow their trumpets from the steeps, she has put into our hands immeasurable physical energy, and into our ears the awe-inspiring voice of her waters. She has likewise, by her noble mountains, sighing pines, her spacious lakes and her vast stretches of lone lands, made a background of glory and mystery, and enriched our imaginations with treasures which are already putting into our literature the soul of poetry. (*c*) But not only has science, with its searchlight, turned backward, given us an outline of the unbroken movement of the development of the world and man, from the simple forms of its beginning to the infinitely varied forms of the present. She has also turned her flashlight on the future, and we are beginning to see reflected from the past, in vague outline, the course and end toward which existence is travelling.

V

In the progress of nature there is, therefore, one immanent and all encompassing Energy at work giving unity and continuity to the whole, and the striking thing is that as the diversity increases the informing unity becomes more marked, for it is in *human nature* that nature reaches its climax of individualism and separateness, and yet, as we have seen, while in advancing civilization the interests become more particularized, the common bond between man and man and between man and lower nature, comes into more distinct relief. If it be said that we are reading into the book of nature a unity which does not exist,

my answer is that, if such should be the case, the whole system of science breaks into fragments and all knowledge is vain—a contingency we need not here take into consideration. Assuming then the unity of existence in which man finds himself inseparably implicated, our question is, what does this unity tell of its inner principle? In other words, what is the intrinsic character of the Energy which is the same at every moment and point of the process, and which gives the process its identity all through?

(*a*) Observe first, in answer to this question, that while the Energy and the process of nature are correlates and never, in nature, apart, they are to be distinguished in thought; just as we distinguish between the creative energy and the process of a speech. The speech, if speech it be, is a unity in difference. It cannot be without energy and process, but they are merely modes of a spiritual monism, which sees the end from the beginning and which moves from intention to fulfilment. So the process of the speech of nature is the mode of the organism's creative energy, and our question is: What is the nature of this Energy? Here we need to be wary and look before we leap into speech. Let science guide us as far as it can show the way. Science proper deals, however, with process alone. It gives us, so far as its observations have gone, a methodical expression of nature's movements, but the question of nature's Energy it hands over to philosophy and religion. It is true indeed that no great student of nature has been able to quench his interest in the hidden (hidden at least to empirical eyes) Force whose laws of action he describes. Every one of them has sought a solution. To Spencer it was the ultimate element behind the vast and varied connectionalism, real, but "absolutely inscrutable." To William James, of Harvard, its effects are felt in consciousness, but in itself it dwells in the subconscious realm and its nature can only be guessed at. But when empirical science confines itself to its proper

field, it treats of the forms, sequences, and orderly stream of consciousness, and not of the intrinsic Energy which gives the stream its unity and direction. But a complete science, a science of the whole, cannot, and, as I have said, does not rest there. By an intellectual necessity it raises the deeper question. It asks: can we know the creative Cause of the creative process? It comes even nearer home and inquires: have we immediately given in consciousness anything more than mere intelligible sequences, forms and processes? Have we any knowledge of an Energy whose very nature it is freely to create, in the condition within which it works, higher forms, and thus to be the principle which gives a rational unity to the life of the individual man and of the race? If so, it is likely the key by which we are not only to interpret the rational movements of our fellow men, but also the creative Cause of the intelligible world.

(*b*) Turning to this question, it is undoubtedly true, unless we discredit our surest knowledge, that we have in consciousness just such free, formative energy. Yea, such energy each man is, for to be man is to be mind, and to be mind is to be concrete self-conscious spirit. and therefore the creative cause of progressive ideals—a progression unending while man remains man, for "the margin of the Ideal fades forever and forever as we move, but it fades not *before* merely, but *into* us." It is needless to argue this. To doubt it is to put in question our most intimate knowledge, and therefore all knowledge. This would leave us in the strange predicament of certainly knowing that nothing can be certainly known. But though we need not waste time in proving man's consciousness of free formative spirit, let us look at it as Wordsworth saw it in a "child."

> "Behold the child amid his new-born blisses:
> A six years darling of a pigmy size.
> See at his feet some new-made map or chart:
> Some fragment from his dream of human life,
> Shaped by him with newly learned art."

In these "maps and charts" "shaped by himself with newly learned art," we see not only the creative spirit of the child, but we see also in its beginning the formative Energy of the rational process of history. This does not mean, of course, as we shall see in a moment, that man creates ideals real, beautiful, progressive, out of an irrational environment as Nietzsche in some of his moods seems to teach; on the contrary it suggests that he forms them in an environment akin, in its nature to his own spirit, and therefore that the all-incompassing and immanent Energy of the developing life of the world and man is spirit.

(*c*) This view, as I read the signs of the times, is the theory which, according to our leaders in science and philosophy, best accounts for all the facts. It means this: Before man appeared the creative Spirit was at work, so to speak, alone, weaving the web of the world. But from the hour when He carried his creative work on from nature in its lower, to nature in its higher form; that is from mere nature to human nature, He had a "co-worker." Man is by his creative spirit a co-worker, and even his weight of body and limb, which makes him less fleet of foot to follow the creative "gleam," does not extinguish "the kindly light;" though, through the haze of his disregard, it becomes to him not a kindly light, but a fierce glare which gives him no rest till he follows it. And thus the primal Spirit, in whom he has his being, so works that even the laggardness, culpable though it be, is made to minister to the end toward whtch the whole creation moves.

(*d*) The evidence that the Energy which gives rational unity and progress to the life of the world, both in its lower and higher form, is Spirit appears to have triumphed, or to be triumphing, in the world of thought to-day. It is cumulative. The instinctive belief of man in all ages and in all stages of development is a testimony to it. Man has interpreted the energy of the wind that sways

the branches of the tree, the stream that seeks the sea, the ocean with its mysterious reaches and its heaving bosom, and the deep blue dome of the sky, and every living thing, as kindred to the spirit in his own breast. This belief that he was in the presence of spirits when he heard an echo in the hollow, or saw the white breakers on the water, he did not fully understand ; nor do we. He misunderstood it to his own injury, but, as I have said, it could not have held its place in the life of man so long had there not been in it a root of reason. Further, our religion, which is this instinctive belief at its highest power, brings home, in convincing form, what we may call unsurmountable evidence that man, when he looks out on his object world, is face to face with the glory of a Spirit "in whom all things consist," and in relation to whom the most enlightened men and women of this enlightened age can find no better way of expressing their adoring trust than in these ancient words, "the Eternal God is our refuge, and underneath are the everlasting arms." If man's experience of fellowship with the Spirit of all things be an illusion, the world is "rotten at the core"—a conclusion not worth considering since science has put beyond question the fact that we live in an intelligible world. Again experiences of our deepest and highest poets are compelling testimony that that the individual soul is "not alone," but is in company with the Father of souls, and

> "Feels through all this fleshly dress
> Bright shoots of everlastingness."

We are all, at heart, poets. And in fellowship with nature through her fleshly dress we are more or less conscious, in our best moments, that we are meeting an answering Soul. Nature takes us to her ample bosom and not only soothes us, but lifts us up into oneness with herself. It has been said by a recent writer that the human breast is the best poltice for a broken heart ; but the breast of nature is a

powerful rival. Nay, is not the human breast nature's best interpreter—her other self. Our late lauriate expressed this when he wrote,

> "The sun, the moon, the stars, the seas, the hills and the plains
> Are not these, O Soul, the Vision of Him who reigns?
> Glory about thee, without thee; and thou fulfillest thy doom,
> Making Him broken gleams, and a stifled splendour and gloom.
> Speak to Him now for he hears, and Spirit with Spirit can meet."

We, each of us, in our best moments feel this, though we may not be able to express it in speech. Even as a brief relief from the routine of life we know the value of fellowship with nature. At the close of a summer day to sit in your bower and feel the leafy arms of nature around you, to climb the mountain and be enlarged by the view, to walk in a forest of solemn pines, and not merely to see this tree and that, but to feel the spirit of the woods. All this soothes and helps to make us sane, as does the companionship of a friend. Even if we are forbidden our run into the country, we can go back in memory to the familiar walks of former days, when

> Meadow, grove and stream,
> The earth and every common sight
> To us did seem apparelled in celestial light,
> The glory and the freshness of a dream.

I know nature has a majesty in her movement which, at times, awes us. Her severity at other times stuns and terrifies. Yet even in her severest discipline there is moderation and mercy, for I observe with thankfulness that when the agony reaches a certain intensity, she graciously administers the chloroform of unconsciousness. I have seen also that when the brave face death in some noble cause, there is an elevation in their souls—the elevation of fellowship with the Other and larger self—which lifts them above the sharpness of death. An English girl, a few hours before her death, at her home in a country parsonage, asked for a pen, and unable to speak wrote these words :

"No coward soul is mine :
 No trembler in the world storm troubled sphere :
I see heaven's glories shine,
 But faith shines equal arming me from fear."

One is almost thankful for death since it calls forth such heroic faith—a faith which does not cower in the presence of the king of terrors, but stands up exulting in the assurance of victory. It is not only heroic, it is an experience which transcends physical nature. Nature, as known to physics, cannot think either about itself or anything else. It does not know, and cannot know, a remembered past or an expected future. It cannot, therefore, think of "glories beyond the world's storm troubled sphere." But nature at its highest—that is human nature—can think. Not only is it true that man can think, it is true also that while he remains man he must think, and among the thoughts he cannot keep from arising within him is, to say the least, the possibility of living "beyond this bank and shoal of time." For whatever may be true of individual men, or individual tribes, history has put it beyond doubt that "man *thinks* he was not made to die," and remembering that this thought is a potent factor in the process of development, it cannot be a mockery and deception ; must on the other hand be in its essence a prophecy of its fulfilment. Thus the soul of poetry, like the spirit of religion, is conscious of fellowship with an answering soul. Philosophy and science, too, are, in the last few decades, looking in the same direction for a theory of evolution which best accounts for all the facts. I have spoken of the primal Energy, and of its explanation as important in the discussion. Now philosophy is discovering that the only satisfactory explanation of energy is to be found in terms of spirit. "How can we think, nay, why must we think that there is in nature the power of doing work which we name Energy?" asks A. M. Fairbairn, of Mansfield, Oxford. And he answers the question

thus: "If we explain it by our experience of resistance,—i. e. by our knowledge that whenever we exercise effort there is something without that resists us, presses against us, overcomes our effort, or is overcome by it,—what does this theory as as to the origin of the idea mean? Does it not mean that in order to the knowledge of Energy without we must posit free power within? We derive the notion of energy, therefore, from our own conscious freedom—the idea of causation in Nature is an inevitable deduction from Will. In other words, a world of necessitated beings could not form or conceive the notion of energy, for the experiences which make the notion possible would be absent. If, therefore, we speak of Energy and attempt to interpret nature through it, what are we doing but constituting nature in terms of personality, using the free formitive spirit within us as the key to open the mysteries or realities which exist without? We conclude, therefore, that energy in nature is the correlate of freedom in man, and were he not free personal spirit he could neither think nor speak of energy." But not only do instinctive faith, religion, poetry, and recent philosophy bear testimony that finite spirits meet answering Spirit in the object world; modern science also, it is coming to be seen, points to the same conclusion. The presupposition and inspiration of science is that the development of the life of the world and man is intelligible. The "flower in the crannied walls," in the whole context of its correlations, could, it is believed, be explained if we had insight and comprehension enough. If, in tracing its life, through its conditioning environment, to its ultimate creative cause, we come to a point beyond our depth we do not despair, because science assures us of the universal rationality of things. This means that we have found nature, so far as we have scrutinized it, intelligible, and are satisfied that it is intelligile all through. Now see what is implied in nature's intelligibility. We speak of intelligible words,

intelligible acts, intelligible movements of troops on a field of battle; we speak also of intelligible movements in the life of a man or a nation, and in the processes of nature. Now, in speaking of words, process or acts, etc., as intelligible, we mean that they are the expressions of intelligence. Consequently, when we call the vast volume of nature intelligible, our meaning is that it is the expression of Intelligence or Spirit. Thus science too testifies, through its fundamental presupposition, that the conscious, spiritual energy, which gives progress and unity to human nature, is the same as that which gives unity to physical nature. And so, unless I misread the trend of thought in the last three or four decades, science, philosophy and religion meet together, or are meeting together in the view that the One creative Energy, which constitutes and develops nature both in its lower and higher forms, is, to use the warmer word, the Eternal God "in whom we live and move and have our being."

VI.

And this leads me to the heart of our problem of supernatural action. (*a*) The order of nature—using the term in its largest sense as inclusive of man—is a dual-hierarchy; that in the form of physical nature, and that in the form of human nature. In the former stage the immanent Spirit works through unconscious instruments, in the latter through the vehicle of conscious spirits. This theory certainly satisfies the unity of life; but it seems, at first sight at least, to leave no room for man's liberty, and thus it appears to cut the nerve of enterprise, to dull the edge of conscience, and to make us feel that we are chips adrift on the ocean of existence and not sailors loving it, and using it as the element in which we are to steer our barks to the shores where lie the richest treasures of life. But this is only in seeming; for a careful scrutiny of

nature, as it manifests itself in consciousness, puts it beyond rational doubt that there is, so to speak, a synergism in spiritual or ideal growth. We freely form and reform our creative ideals *because* their primal Creator is forming them within us. We work out our own salvation because the universal Spirit is "working within us to will and to do of his good pleasure." The nature of this correlation of spiritual facts is a difficult problem; but, since the correlation belongs to a rational universe, we need not despair of a solution. This, however, seems to be clear. In the synergism the universal spirit is supreme. He does not, it is true, reduce the spirit of man to a mere instrument, but sustains him in the status of a conscious co-worker. He nevertheless, in the evolution of history, so generates ideals within him that he cannot altogether escape them, for to be man is to be mind, and to be mind is to think, and to think is to form, out of the element in which man lives, ideals—i. e. "the light that never was on sea or land," that "lighteth every man that cometh into the world," "that is the master light of all our seeing," and that reveals our evil and makes us "tremble like a guilty thing surprised," and gives us no rest till we arise and follow "the gleam."

Every higher ought in the soul springs from the primal spiritual Energy, without which we could not have made it our own. It was first His, and even after it has been received it is still His. So we may reverse the words of Tennyson and say, "Our wills are His to make them ours." This law of spiritual development, by which we make the higher will of another our own, is illustrated in every life. I knew a man in whom, up to a certain time in his life, the "ought" in his experience was as the command of a sovereign, but his life was grafted on another life in which was, so to speak, a sweeter sap, and from that time the fruit of duty became the fruit of love. May I illustrate this way of the Spirit by a simple incident from my early

student days when the creed which I had inherited was still an unbroken, even, unchipped crystal. I was thrown, in my Glasgow University time into the company of a young minister who had felt the air of the modern uplands. In conversation, to my astonishment, he expressed, in a moment of confidence, a doubt as to the pre-existence of Jesus. In my then untravelled inexperience I was shocked and said to him, "Mr. H., suppose you were dying at this moment, and, going into the presence of Jesus, found you were wrong, how would you feel?" "I believe," said he, "Jesus would not blame me for suspense of judgement when, to me, the evidence is not quite clear. I would be on my knees at the Master's feet, and I can imagine Him with the kindness of His days in the flesh, putting one open hand on one of my cheeks and the other on the other cheek, looking with His fine eyes into my face and saying, 'my little boy, what was that you were saying down there?'" From this seed of truth there began to grow in me the flower of an honest mind, and it has ever since been growing in the air of the spiritual uplands in which my friend lived. Thus, while I have been working out sincerity, my friend has been working in me, and the Eternal Spirit in us both.

(*b*) But man not only shares the ideals of the Eternal Spirit, he is also a "partaker" of Divine Power to give those ideals a local habitation and a name on the earth. He is a "co-worker with God." It is not possible for him, it is true, to change the laws of nature, for these are invariable, and it is well that they are so; otherwise we could not lay our plans for seed time and harvest, rely on water power or electric energy to turn the wheels that grind the grain, or have confidence that the flour will nourish. But while we cannot change the laws of nature, we can, and do, change and readjust the order of nature. We adjust the order to the accomplishment of higher ideals. "Life is one stupendous succession of interferences. We

never lift a finger, or do a stroke of work, or even think, but that we interfere and change the current of things. Fire burns, but we do not let it burn at its own sweet will. We control the burning, we imprison the burning, we turn the burning to account. Water seeks its level, but we do not allow it to keep its level. Are we helpless in the presence of lightening? Once a tyrant, electricity is now our slave. He sheds radiance on the midnight streets. It is only a question of knowing how to do things. We can do anything with nature if we only know how." Thus man, in the measure in which he knows how, and under the conditions in which he lives, is superior to nature's order. His life, looked at in the history of the United States or our own country, from the days of the primeval forest to the present time, is, to use the words of the writer just quoted, "one stupendous succession of interferences with the order of nature." He has transformed the old order into a new and higher. He is therefore, in a true sense, above nature, in other words supernatural. In this sense he is the conscious vehicle through whom the eternal immanent Spirit is progressively transforming the order of the world.

The transcendent, or, in the sense explained, supernatural work of man, is seen at home when we compare the Canada of to-day with the Canada of four, or even one, hundred years ago. The heart of the early settler sometimes sank when he stood with his hand on the heel of the handle of his axe, looking round on the giant trees and thinking of the long task before him; but, by the transcendent energy within his breast, he mastered his feelings, and, having begun his great undertaking, he kept at it till his "night came." But his sons were baptized by his spirit, and so he and they have

"............slain the beast and felled
The forest, and let in the sun, and made
Broad pathways.........................."

The pathless forest is now a land of highways. The Indian clusters of wigwams have given place to fair cities, some of which begin to rival, and will, ere long, equal the leading cities of the world. Our waterfalls are no longer allowed to merely indulge in their titanic sport of roaring over the cliff and plunging into the abyss beneath ; they are compelled, by the cunning power in the breast of this being who appears a lilliputian beside them, to put their shoulders to the wheels of progress, and thus to send coursing through the land the electricity which is to light our cities, waɹm our homes, and do all manner of useful work. Thus to know what we have done to shape a new order out of the order found by the early settler, we have but to look around. But to know what we are going to do, we must take counsel of our dreams. We have the vision of a fleet of fast ships which are to bring us in touch of all ports. We see, also, fore-gleams of a time when the racial and creedal divisions of our people will no longer prevent them from feeling that they are of a common origin, living a common life, and the heirs of a common destiny. We see coming, too, a social order firmly knit with the puritan muscles of sobriety, integrity and reverence ; while at the same time it exults in the joy of exhistence. We live in these supernatural dreams, or, if you will, they live in us, inspiring us to bring them down out of the timeless and set them in the order of time. And I believe it is only sober truth to say no man can, as yet, imagine either the vastness or beneficence of their achievements.

And the light of this transcendent dream of a new order of society shines not only in the soul of our people, but of mankind, and having absorbed those rays, mankind can never be as it was before. A significant sign of this is found in the Hague Peace Conference. I know it has been laughed at, and it may be true that among its members there have been representatives of nations who were

using it for their own ends; but, however, this may be, it stands before the eyes of the world as the visible symbol of a combined movement to bring peace on the earth. The goal may yet be a long way off, but we must remember that every great achievement is, at first, only an ideal or prayer; and this we may affirm, that the soul of the race will cease to be true to itself when it ceases to cherish and labor for the fulfilment of this ideal. The individual may, and does fail, for a time at least, to follow his or her "gleam," but that the race should finally fail of its end is a pessimism which cannot be entertained by one who believes that the life of the world and man is a movement from intention to fulfilment. And the facts of history are against such pessimism, for the belief that all men "shall brothers be" is the ideal hearth of humanity. Its glow is beginning to be seen and to attract the scattered family, to light up their faces, to warm their chilly hands, and to make them feel that they are children of the one Father, and joint heirs, with the Chief among the brethren, of the privileges of the home.

In view of these transcendent ideals and achievements of man some principles come to light. To begin, it is implied that man, while in the order of physical nature, transcends, and uses it to realize his ideals. It appears also, that his transcendence lifts him above the individuality of things and of himself, so that while mankind is made up of an innumerable number of individuals, manhood is one: a unity realizing itself in difference. Further the unity of the race is not a bond imposed, on an aggregate of individuals, from without. It is, on the contrary, a spiritual principle which belongs in common to every one of the individuals. In one sense they are many, in another they are one. Thus, man, being intrinsically a partaker of transcendent or supernatural energy of spirit, achieves supernatural ends, and cherishes supernatural ideals; therefore, it is natural for him to be the personal vehicle of

supernatural work. The natural and the supernarural meet in human nature.

Two questions, which have a fascination for lovers of the occult, are suggested by this discussion, though here they cannot be dealt with. The first may be stated thus : Does the primal Creative Spirit, by special interposition in His own order, raise it to a higher ? The second is : Does He interpose through other spirits than those in the flesh ? In answer, which must be perfunctory, suffice it to say in reference to the latter question, that the tendency of the modern mind is to be incredulous of ghostly interference, either in the physical or psychic order of nature. As to the former query, observe that it is not : can the Primal Spirit interpose ? It is : does He ? Observation of nature must decide. Now the outstanding stages in human development, as every student of history knows, have been associated with certain great personalities, who became the embodiment and symbol of the ideal of a new and higher order which had been gradually coming into the consciousness of the community. Thus the development of human nature, individually, socially, nationally and as a race has been achieved through and by human personalities. In other words, man, as the personal vehicle of the progressive ideal of humanity, has been, by virtue of his implication in the Eternal, working out his perfection, while the Eternal Spirit has been "working in him to will and to do of his own pleasure." And, let me add, the Highest among men has been, is, and ever must be His most powerful winsome and transforming personal vehicle in creating the new heaven and the new earth.

Coincidences, Luck, Chance

BY J. DAVIS BARNETT, STRATFORD

Read before the Hamilton Scientific Association, April 10th, 1908.

Travelling east of Toronto recently, I spoke to an elderly man I thought I new. I found that I had his sirname, his professiou and his residence town absolutely correct; but nevertheless it was not my old acquaintance, although some fifty years ago he had been a pupil at the school of the man I had mistaken him for, and with whom I was then chatting.

When younger, and more fond of social functions than I am to-day, I did not get a wedding invitation one year until late in the fall; but, for that day, eventually got two invitations, in different towns. When I arrived at the earlier, I found the groom's birthday and wedding-day coincided. This cannot be counted as a "coincidence;" but that it was his sister's birth anniversary, and that they were not twins, can be.

The display of wedding presents was so large that it was a matter of surprise that there was but one case of duplication, but that was perfect. Reading the cards on these duplicates I noticed the sirname was alike, the preceding initials were alike, but one was Mrs. and the other Mr., and they came from towns far apart.

In the course of a long tramp in England five years ago, my brother and I walked up Hay Tor (Dartmoor). Being warm when the summit was reached, we wind-sheltered under the lee of a large boulder, where, with the sweep of a large prospect, neither person nor habitation could be seen. Eventually the head of a man was seen, following up our trail, and when he came close (to his sur-

prise), I addressed him by name. I had not seen him since saying good-bye in Montreal thirty years before when he was removing to England, and it was in this isolated, desolate spot I met the only Canadian face I did meet in a pleasant 3,000 mile tramp.

It is purely an accident of railway life that, what many visitors have said is the most complete collection of Shakesperiana in the Dominion, should be located at Stratford-on-Avon; that the personal notice scrapbook of M. Barnett, playwright and actor, should fall into my hands, and that at points, some hundred miles apart, on this continent I should pick up two Black-letter English books, each containing the delicate autograph of White Kennett, historian and bishop, noted as one of the very early and enthusiastic collectors of Americana.

Do many of you recollect Lord Macaulay's favorite coincidence story, as quoted by that genial soul, Wm. J. Thoms, editor of "Notes and Queries," and librarian to the House of Lords? Macaulay wished to verify a quotation from a commonwealth pamphlet before sending a volume of his own writing to press. Not finding his own copy of the booklet he applied to the British Museum, the Bodleian and at Paris, then to the book-dealers of London and Paris. all fruitlessly. Walking one morning before breakfast, as was his habit, he stopped to examine the stock of a small dealer in second-hand books, who was putting outside, baskets marked all at 2d, 4d, 6d each. Finding a book in the 6d basket that pleased him, he tendered a half-sovereign in payment. The dealer, smiling, said, "it is too early for me to change gold, if you have nothing smaller, will you keep shop for me while I see if I cannot get change?" The unknown would-be purchaser said yes, and walked inside the deep, narrow, dark store, and slowly continued his walk down to the brightest spot in it at the far end, where a horizontal ray from the rising sun, coming through a broken pane of a grimy end

window, fell diagonally on a side shelf and directly on a copy of the rare booklet he practically despaired of ever seeing again. Think of the many "ifs" that can be put into the moralizing of this story. Thoms goes on to say, that an endeavor was made to cap this story by a friend, who said that, going to office one muddy morning, he dropped a shilling on the edge of the Strand pavement. Poking for it in the slime with the point of his umbrella, and not seeing it, he went on to business, and thought no more of it until going home at night, he bethought himself and said, "I drop't a shilling here this morning," and looking down at the spot he found twelve pence wrapped up in brown paper.

In French history 1794 is properly called the period of Robespierre. If to that date you add those same figures, simply as detached numerals, 1, 7, 9 and 4, you get 1815, the date of Waterloo. Treat that Waterloo date just the same way, that is to 1815 add 1, 8, 1, 5, and you get 1830, the date of the revolution. Treating 1830 the same way you get 1842, the death of the Duke of Orleans. Now, if this numerical scheme were a system of divination, the next national important event would have fallen on 1857, but it came in 1848. However, 1848 has its little date legend. For Louis Phillipe came to the throne in 1830. He was born in 1773, which, treated as a string of numerals and added to 1830, makes 1848. His Queen was born in 1782, which similarly added to 1830 makes 1848 ; and they were married in 1809, which added to 1830 also marks the ominous year 1848. Then note, Louis Napoleon became Emperor in 1852 ; add as numerals the date of his birth, 1808, and you get 1869. Again, to 1852 add the birth year of the Empress, 1826, and you get 1869 ; and they were married in 1853, which added to 1852 also makes 1869, the date of active friction that in six months culminates in his disastrous war with Russia.

The Italian summary of Napoleonic coincidence

relationship to letter "M" is very full, and therefore probably too long for this communication, yet what R. A. Proctor (who has a good chapter on coincidences), thought an extraordinary story should be given in a condensed form "Dr. T. Young was trying to interpret the famous Rosetta Stone. Sir G. F. Gray offered to place in his hands the fruits of his Egyptian finds, including a papyrus from Thebes. Before these reached Young, a man named Casatic arrived in Paris, bringing Egyptian MSS, among which Champollion noted one whose preamble looked like the text on the Rosetta Stone. Dr. Young then procured a copy from Casati, and while trying to translate it Sir Gray's papyrus arrived, and to his delight he found it was a translation of the Casatic MS. Young's comment was: 'The most extroadinary chance had brought unto me the possession of a document which was not very likely ever to have existed, still less probable to have been preserved uninjured nearly two thousand years; but that this very extraordinary translation should have been brought safely to Europe, to England, and to me, at the very moment when it was most of all desirable to me to possess it, as the illustration of an orignal which I was then studying, but without any other reasonable hope of comprehending it—this combination would, in other times, have been considered as affording ample evidence of my having become an Egyptian sorcerer.'"

Rose Eytinge, the actress, says, six years ago in London I knew two young men, modern editions of Damon and Pythias. They had to part, and the evening before leaving they supped with me. I rallied them on their melancholy mood, and, merely to raise their spirits, without any serious purpose, said, "we shall all be supping together some evening this month five years hence." One twilight, last summer, I was looking from the window of a Broadway hotel, when I saw Damon on the opposite side. He recognized me, crossed over, sent up his card, and eventually asked me to go with him to Delmonicos', this being his first visit to America. After giving our order, I asked about Pythias, and he was in the act of telling me that he had not heard from him for a long time, when we saw a gentleman enter the room, with the air of one who finds himself in strange quarters. It was Pythias, who

arrived that day by the Liverpool Steamer, Damon having arrived by train that day from San Francisco. Neither had any idea of the other's whereabouts, and comparing notes, we found it was just five years that month since I said we would all be supping together. And we supped. As might be expected, from an observing actress, her coincidence list is a wide one; coupling the Mediterranean and Delmonico's, Egypt and Michigan, Cairo and Galveston (Texas). A South American specimen is good. She was walking the Strand, London, with a friend who described his narrow escape from a shark, while bathing in the Amazon; and he extolled the bravery of his companion, who did so much to save him. While expressing his regret that he should never meet the brave fellow again, he exclaimed, "why, my goodness, here he is," and at once they were vigorously shaking hands. Lord Acton's favorite coincidence story was, that the three men executed for the murder of Sir E. Berry Godfrey, at the foot of Greenbury Hill, London, were named Green, Berry and Hill.

Does some one ask why do I repeat these idle tales? Because such stories were at one time considered occult rather than idle. To-day we are content if they prove interesting enough to fill a gap in talk, or cause a gentle lift of the eyebrow. At one time they were considerd as in some way the outcome of cause, or even in themselves causal, and our altered relation to them—the only point I wish to emphasize—is one of the signs of the times, an actual mental asset, to be measured, priced, and its value (as the commercial men say) extended in any twentieth century intellectual stock-taking.

Change in the human common point of view is a subtle but pervasive thing, almost as obscure and unnoticed as the rate of travel of a glacier, and my object to-night is, by noting the altered position of a few pegs, driven in on the surface of some of these human movements to thus

remind you, that seemingly hard crystaline things do flow, and the greater in bulk they are, the more certain the flow.

I hope you noted, during this varied story recital, that you did not, in any case, say to yourself, this event is predictive. No one said of any story, this shows the designing hand of a Providence; this indicates malign purpose thwarting us, or, this shows good and evil powers in active antagonism. I felt sure that the utmost that these stories would do would be to start the lowest form of wonder, and this certainty about you is also one of the signs of the times, a surveyor's point of triangulation in chaining over the direction we have moved in and are now moving.

Even the historical date stories had no foretelling value; they are but curiosities, classable with the arithmetical treatment of the year-date that amused people in 1881. Read from right to left or left to right that date comes out just the same. The first two figures (18) divided by 2 gives 9 as a quotient; the last two (81) divided by 9 gives 9. The total (1881) divided by 9 contains 9 in the quotient, or multiplied by 9 contains two nines. Then 1 and 8 are 9; 8 and 1 are 9. If the first two figures (18) be placed under the second two (81) and added, their sum is 99. If added as a string of numerals, 1-8-8-1, the total is 18 or two nines, and the first two numerals is two-ninths of the last two. This date also reads the same and has all these same irrelevant combinations if turned upside down.

However, these French dates would be likely to call to your minds the thousand and one ways of getting the prophetical number 666, and also the wealth of books, dealing in prophesy, that English people alone have produced. I have an impression (exaggerated you may say) that between 1860-80 one twenty-fifth of the books—other than school books—ordinarily to be found in the sort of second-hand book-store that never issues a catalogue, were on the subject of prophesy—I mean, were attempts at

the interpretation or foretelling of the future. And that that literature is dead to-day—dead and gone—is another sign of the spirit of the times.

I have not, in these stories, given any specimens of geometrical and mathematical coincidences, but those who are familiar with C. Piazzi Smyth's work, "Our Inheritance in the Great Pyramid," will remember that its whole elaborate argument is based on what appears to be a remarkable string of such.

The author to read, after you have got through with the book of the Astronomer Royal for Scotland, is A. de Morgan (Prof. of Mathematics); especially that rare and racy book, compiled by his widow (principally from letters to "the Athenæun"), titled "A Budget of Paradoxes," and you will see that the coincidences are in the geometry, rather than in the Pyramid, and that in rigid mathematics there are as rich and unexpected fields of relationships as in any other section of nature or life; but that they have no significance outside that common relationship between all number and form.

How many coincidences should be linked together to produce on a normal mind the conviction of purpose or design in them, is too large a subject for so brief a paper as this; yet I observe that the puerile detached collection of alleged single coincidences, forming the main part of Mrs. H. Pott's thick book, "The Promus of Formularies and Elegances," has, on some persons, a stronger influence tending to prove the Baconian authorship of the Shakesperian drama, than has the whole cumulative list got by Dr. J. A. H. Murray (from material prepared for his New English Dictionary), npon "verbs in out."

In the printed Shakespearian works, "verbs in out" occur at least 54 (I think 56) times. In 38 of these cases Dr. Murray finds no earlier use of such word combinations, and in 9 of these their use is confined to the so-called Shakesperian works—that is no author, of the thousands

who were so carefully read for this Dictionary, has used them ; so that whoever wrote the Dramas was apparently and quite unconsciously in love with that form of verb.

Now, in the whole of Lord Bacon's printed works there are but 2 "verbs in out ;" one being "outshot," a street word in those days when most men were archers.

Are totals of 54 to 2 "verbs in out" enough grouped cases for to found a coincidence faith upon, that the two sets of writings, with the hitherto unknown marked difference between them, cannot be by the same author, Bacon? Single coincidences have been known to make a strong impression on some types of people. May I quote John E. Purdon, A.B., M.D. ("mind," Dec. 1900, pgs. 163-4), who says:

"We are generally accustomed to consider the fall of well shuffled cards as little different in character from that of coins thrown up at random, either singly and successively, or simultaneously in large numbers. In fact, we incline to consider the fall of cards, as regards dealing and drawing, as altogether a matter of "chance." There is *no* doubt that in a million deals the tendency to uniformity would be *strongly* manifest, and the established laws of probability would assert themselves. But the essence of the peculiar is that it is the particular, and that it must be studied separately, not according to statistical methods."

After quoting what seems to me, as a whist player, only an ordinary whist experience, he goes on to say :

"I would not feel justified in calling attention to this case if I had not had some special experiences that support me in laying stress on particular occurrences happening to myself, as when I saw the remarkable fact of the turning up of the same three cards to me, after a dispute among some young officers (in which I was in the right), during which I threw down the cards indignantly, and called for a re-deal, saying, 'Let the cards settle it themselves.' The game was 'Spoiled Five,' in which the five and knave of trumps, and the ace of hearts, played in any order, must win. I held these cards, but some stupid objection being made to my laying them down on the table (done by me), on the ground that a gentleman would not play out the hand on a certainty, the above extraordinary event (of the same three cards coming to me) took place. It was a

true instance of magnanimity; a spontaneous response by his higher powers, to the appeal of outraged honor, on the part of a man who would not maintain his rights in a vulgar squabble."

Even such a believer in the occult, as Dr. Purdon evidently is, incidentally says, that in cards, if you take instances enough, the Laws of Probability will assert themselves. So much is this so that to many of us to day the marked feature of all games of pure chance is their certainty, the sureness of the ultimate figures, the certainty of the definite income to the Bank, where the Bank is honest, as at Monaco. The percentage is sure, the results foreseen, so that the balance was never found to be on the left side of the page by Monte Carlo's accountant.

The modern trained mind recognizes *Law* in this, sees that something re-occurs regularly, and that *something* is in "the game," is in the so-called chance; so that you will observe without changing the word we have transposed the main thought that the word "chance" now connotes. This is another part of our barely recognized mental outfit, decidedly separating us from our grandparents. For us, what was an erratic perchance, now spells scientific certainty; uniformity of result is seen under a domino of lawlessness, and this is an item to be remembered in our intellectual stock-taking. For, as Prof. J. Venn (Cambridge Logician) says:

"The clear and adequate appreciation of this kind of uniformity may be regarded as the great logical achievement of modern times, that is—our having a consciousness of average regularity—of regularity in the long run, combined with absolute irregularity in the details."

I assume you all know the simpler proofs for this belief, most easily seen by counting and tabulating the results of the toss of a coin, the throwing of perfect dice, and the turn-up of cards. In these easily grasped experiments and illustrations the operation of the law can be seen with the least qualifications the current least influenced by cross flow; but it is as certain in its action in

matters of mixed skill and chance, and ultimately the student sees it traceable in pure skill and throughout all nature, so that by this avenue, through such a brain opening, enters the idea (and ultimately the belief), that it pervades all the phenomena of life, mental and physical.

This, I take it, is how the reasoning is done; but in practice the entry of the thought seems to have been made as often through the avenue of Betting, thence up to Insurance, which two opposite things seem as yet hopelessly mixed together in the minds of the masses. However, in the eyes of a "real sport," all Insurances that actually insure are dishonorable betting, because Insurance is done on a known certainty—an average or long-run certainty, a quality of certainty practically unknown when many of us went to school. There some of us learned how to work out permutations, but the ordinary idea we then got was that some such results were possible; not that they were probable, much less was the idea brought home to us that they were actually and operatively certain in daily life.

May I emphasize this recent view of long-run certainty by briefly listing some modern Insurances, viz: Against life, as twins and triplets, as well as against death, accident, injury to person, and single blessedness. Against plate glass fracture, burglary, fire, lightning, hail, wind, flood, in fact against all forms of storm and wreck, including explosions; against property title transfer and other legal errors, and many kinds of fraud and trust betrayal. These things are now seen to keep proportion and bounds, so that the losses they entail, being widely distributed, are lightly borne; and the possibilities of the future look less malignant to us, as we recognize life to be the theatre of causes and laws—a close spun web of interlacing effects, a field of persistent regularity in births and deaths, sexes, size of stature, number of men of genius (as Galton shows), climate, temperature, electrical tension and discharge, vegetable and animal growth. Such thoughts bring up recollections of T. Buckle, whose "History of Civilization

in England" is for some of us the first axe-blazing, marking out the first broad cart road into the wilderness, and I yet retain a vivid recollection how the laughing incredulity of an emotional Canadian family met the boyish emigrant's statement (which I had got from Buckle's book) that in England the total marriages per year per thousand were a known and definite factor of the average price of corn (wheat).

Like many other enthusiastic pioneers Buckle made errors, and we, standing in the opened clearing, easily see that they are errors. When he comes to such a matter as murder and suicide averages, being foreknown with the certainty of a chemical formula, we now see that for his statement to remain true it has to be predicated that the people themselves—and more especially their environment—does not markedly alter. May I use a simple illustration? If you make a true die or cube of raw bone, and properly mark its six faces, you will practically get "ace up" 100,000 times in 600,000 throws. But should this raw bone be somewhat tuberculus, so that in drying out it did not condense evenly (not necessarily altering the truth of the shape, yet slightly altering the centre of gravity) we shall then see, that the expected proportion of it turning up 1 to 6 will be altered; and the rate of alteration possibly influenced by the energy with which the die is thrown up, or the distance it is allowed to roll. So among a people, if they or their environment be altered, then it is certain their resultant behaviour will be altered also. Hence, during a wave of emotion—or, say epidemic sickness—it would be foolish to predict the number per thousand of suicides or murders.

Buckles' actual relationship figures, at many points, cannot now be quoted as accurate, because he did not see—or allow for—the qualifying action and re-action of environment—that is, he was in time, pre-darwinian and did not know that these neglected dice he was just learning to ob-

serve were slowly altering their centre of gravity. Nevertheless, all interested in the record of mental progress, revere the overworked student who died young, at Damascus, with the moan "Oh, my book, my book, I shall never finish my book!"

Pardon this digression on Buckle, and permit me to hark back to chance—in its old sense of "perchance." I have tried to get information as to the numerical probabilities of being correct in pure guess-work; but apparently this field is as yet, almost virgin; or I have not looked in the right spot for the results of such experiments, and the whole matter is more complicated than it appears to be at first sight, for there are at least two unknown factors (possibly more) in the attempted solution of such equations; (*a*) of variation in the thing to be guessed; (*b*) of idiosyncrasy in the guesser himself. May I illustrate the latter point by saying that some years ago, a firm in Los Angeles put a very large squash uncut in their store window, advertising a prize of $100 to the correct guesser of its contained seeds. The only requisite being, to enter and register, name, residence and guess number. There were three correct guesses; (811) in the 7,700 who registered. Most of us would, I think, infer that the squash was the only factor requiring consideration, but an analysis of these 7,700 guesses shows that the guesser is not an absolutely free agent; unconscious as he may be of any bias or tendency in himself; for, tabulating this long string of guesses, it comes out clearly that this fairly representative people had themselves an unknown preference for certain numerals. Ignoring the hundreds column and totalling the tens and unit column the choice in numerals stood thus: First in rank O (used 2,102 times); then No. 7, (1977); No. 9 (1650); No. 5 (1629); No. 3 (1463); and No. 1 (1305); then follow the even numerals, No. 6 (1080); No. 2 (965); No. 8 (933); and No. 4 (831); which result shows clearly our strong preference for the odd numbers and for

No. 7 among the odds. In fact the preference for No. 7 is so marked that the alliterative conbination No. 777 occurs more often than all the combinations 770 to 779 added together, and it is seen that such similar alliterations occur more often by sixty-seven per cent. than any other form of combination ; so that noting the alliteration of despised No. 4, the number least desired of all the even numerals, it is seen to occur twice as often as No. 443 or No. 445.

May I here digress again ? so far as to say, that this spontaneous reluctance to use No. 4 deserves a special investigation, in view of the way that number and its factors is favored as called upon for heavy duty by those who antagonize the introduction of decimal notation and metric weights and measures.

Before leaving this to me, interesting questinn of probable correctness in guessing, will you bear with me while I quote from some recent experiments by Prof. T. Wertheimer, Principal of the Merchant Venturer's Technical College, Bristol. His wish was to find the quantative or measurable truth in the work of professional, and even titled amateur "dowsero" (water diviners) for dowsing is yet a common and advertised business in England.

The whole series could not be here reproduced understandingly without wall diagrams, and apart from that difficulty the locating of under-ground water is not easy to test ; because, if the well you have put down prove dry, the dowser can always say "you did not go deep enough." But the dowser's alleged ability to recognize above ground the fact of water flowing or not flowing through a pipe, is more easily tested ; and with the help of Bristols' W. W. Engineer, a series of tests made by turning the city pressure off and on through an opened three inch suburban main, were carefully carried out, with a forty per cent. success for the dowser's trials. The Professor then carried out a similar series of tests, or rather in this case, pure guesses, with the help of eight of his students, young men

just ready to go up for their B. S. Exams.; and they together achieved a forty per cent. success in ten guesses each, that is, they were right thirty-two times in a possible eighty. This is the point for which I quote, and which I wish to be remembered. But incidentally the whole series shows that dowsers' reports made after testing the same piece of land did not agree among themselves, and I may add what Abinus said in his quaint way in the year 1700. "I ween that no confoundeder thing is to be found in the world than the divining rod business, for whatsoever is right and fit according to one, the same is wrong and unfit according to others, until there is no good to be presumed out of so great confusion."

The Professor's further tests will be watched with interest. As compared with Coincidence, Probability and Chance, change in opinion and sentiment about "Luck" commenced so early in historical time, that it leaves but little variation to be noted in the present-day point of view, and there is no appreciable alteration in the word's meaning.

Of all the early ordeals (primitive testing for crime) as by fire, boiling water, the balance, poison, wager of battle, etc., etc., of attempts to foreknow; those, by lot drawing, the most crude form for testing one's luck, I know, seems to have been the first to weaken in the aboriginal faith. You now have to go far down in the social scale to find one who will draw lots for proof, or who fully believes in so trying his luck; and certainly no common sense person trusts the man who has a conceited belief in his own luck, a state of mind on our part for which the new psychology has ample explanation. The one curious point I notice about this weakening confidence in personal good luck is, that apparently it does not at present decrease gambling. I have no personal experience of its fascinations, and therefore cannot "speak by the card" but when a wave of moral legislation made the common old fashioned sweepstake just as criminal as any other form of lottery, it quite unexpectedly seems to have increased instead of decreased the mania for betting, by forcing the poorer to

stake their money in the same way as the well-to-do club men staked theirs. In horse racing for instance, they had after the passage of this statute to bet on a particular horse or specified group of horses or stop gambling. This made, or eventually seemed to make some call on their knowledge judgment or shrewdness and resulted in making betting sport more interesting to them. You see, the sweepstake they had been used to, was a trust in sheer luck, whereas the backing of some particular horse, or named group of horses, turned out to be an attractive union of their good judgment and their good luck, giving them apparently two forces in their favor instead of one, and the same kind of appeal to a mixed personal vanity and luck, has been the stimulation of stock gambling, ever since the Joint-Stocks Limited Liabilities Bill became law, and it opened the way for produce gambling.

Stock and other quotation journals, racing calendars and newspapers came in only when the not rich man wanted information to be used in supplementing his faith in his luck.

From the ethical side, the bright feature of the case now is that, when the man has lost his money, he feels that all the blame cannot be carried by "his luck;" some of the fault is in himself, and in that way will ultimately come gambling reformation, I expect. I have probably taxed your good-natured patience to its limit, and will stop, hoping that the effect of this Paper will be a sense of encouragement in that superstition is visibly narrowing, the range of law widening, the province of fear lessening, and that the happy progress of the world in these directions is helped by such institutions as the Hamilton Scientific Association.

The Petroleum Industry of Canada

BY NORMAN L. TURNER, M.A., BELLEVILLE

Read before the Hamilton Scientific Association,
March 13th, 1908.

The petroleum industry of Canada is one of the most interesting and least known sources of her wealth, although of small proportions as compared with the immense developments in the United States and Russia, it has still had a marked effect on the economic development of this country.

During the year 1907 crude oil, to the amount of 788, 872 barrels, with a value of $1,057,088.00, was produced. This amount is an increase of approximately $300,000 over the previous year. During the last ten years the production has ranged in value from $700,000 to $1,200,000. In 1899 the highest point was reached, namely $1,202,020.

Comparing these figures with those of other non-metallic minerals, it is seen that the petroleum industry ranks third in the list; coal first with approximately $24,000,000, asbestos second with $2,500,000, and petroleum third with $1,000,000. These figures will convey in a small measure the importance of this industry.

The Canadian oil business is really the first of its kind to be worked on a systematic commercial basis. The previous oil industry was in Scotland, but the oil in this case was not obtained from wells, but from the distillation of oily shales which are found in that country.

Long before Col. Potter struck the first oil well in Pennsylvania, prospectors and oil men, mostly Americans, were developing the Canadian fields. In fact, so great was the yield of oil in this country that the United States

Government placed a heavy duty on Canadian oil, which duty still remains, although it is many years since there was any possibility of the Canadian oil competing with the American product, in fact a large proportion of the oil burned in Canada has been imported from the United States.

Although "shows" of oil have been discovered in Canada, from the Gaspe Peninsula on the Atlantic to the Rocky Mountains on the west, the only really important petroleum fields yet worked in Canada are those of Lambton County in the south-west corner of Ontario.

Even these, despite the utmost activity of the oil men, have been unable to keep up the growing demand for coal oil and the other petroleum products, and for years past over thirty per cent. of the oil used in Canada has come from the other side.

It was away back in the early sixties that petroleum of Lambton County was discovered to be of commercial value. Long before the white men ever visited the county the Indians knew that it was rich in oil. It oozed up out of the ground and floated down the streams. The Indians used it as a medicine, and when the early settlers appeared, three quarters of a century ago, they did the same—the oil being regarded as good for rheumatism. Many of the early settlers made considerable money by gathering the oil off the surface of the waters of Bear Creek and peddling it around in small bottles as medicine. Their method of gathering the oil was to float a blankent on the surface of the water and let it absorb the oil, and then remove the oil from the blanket by wringing.

These conditions did not last long however. The fame of the oil soon spread, and it was not long before prospectors and others figured out that there must be some resevoir to supply this surface oil. A surface well was dug about 1863 on the edge of Bear Creek, close to the present site of the town of Petrolia, and a good supply of oil was

obtained. At first it was thought that it was all "surface oil," which was then regarded as a very valuable lubricant. Later, however, several adventuresome spirits resolved to try deeper down, and with infinite pains and labor a hole was drilled several hundred feet into the ground. The result justified their work and a flowing well was struck, flooding the district with oil, which ran away down the creek.

News of the strike spread quickly and a terriffic oil craze set in. Prospectors came from far and near, through the woods of the oil fields property was taken up in all directicns, and hundreds of wells were soon under way. There was any amount of excitment and industry, but very little money in those days, but every one was confident that they were on the edge of a bonanza, and worked with feverish enery to get their wells down and watch the oil waste itself away on the ground or down the creek.

Putting down a well in those days was a matter of tremendous labor, and took several months, while to-day a well is sunk 475 feet with little trouble in a week or less. After the surface earth was bored through to the depth of nearly a hundred feet, there was three hundred feet of hard limestone and other rock strata to be drilled through before the oil bearing strata was reached. This is a strata of porous brown rock, limestone, from five to ten feet in thickness, heavy with petroleum. To drill these wells in the old days a heavy drill and sinker was hung in the well from a long pole, and balanced over the hole on a fulcrum, which gave strong leverage. The driller walked to the end of the pole which pulled the drill up, and then jumped off letting the drill go down with a bang, this slow process was repeated until after months of effort the well was finished. It was an infinitely tiresome process, but was generally rewarded as almost every well flowed immense quantities of oil, which was then very valuable indeed, at one time going as high as eleven dollars per barrel.

After operations had gone on for some time at Petrolia, it was discovered that there was a richer and shallower pool a few miles away, at Oil Springs, and the original fields were deserted in the general rush for the new field. The first flowing well was struck on the 19th of Feb., 1862, when Jas. Shaw, Esq., of Oil Springs, found oil at a depth of 160 feet in what is now known as the Upper Vein. The well flowed 3,000 barrels per day, some of those struck a short while later flowed as high as 7,500 barrels per day.

The production of oil became tremendous and the price dropped from $10.00 per barrel to 20 cents. There was as yet little market for the oil, and no means of storing it, while new wells were being drilled every day, flowing thousands of barrels of oil. The whole district became soaked in oil which floated down Bear Creek by the millions of barrels, until the creek was inches thick with the precious fluid. Finally the oil caught fire and for miles it burned with inconceivable fury. It is estimated that in this fire at least 5,000,000 of barrels were consumed, the fire lasting for days. The oil flowed down to the mouth of the river and was noticed on the navigable portions of the Sydenham River, where vessels were smothered with the tarry mess.

Nothing, however, could stop the speculative fury. Drilling went on undisturbed, properties changed hands at fabulous sums, and on all sides the most extraordinary activity was manifest. Speculators flocked in and it was not long before several small refineries were built, which gave some small outlet for the immense production, despite the fact that there was not a railroad within miles and the oil had to be teamed out.

Fortunes were made one day and lost the next, and there was all the ups and downs of a typical mining camp. The population of Oil Springs grew to nearly 10,000, and there seemed no limit to the wealth. As an example, one

of the wealthy men of Canada, John B. Fairbank, came to Oil Springs at that time with very little capital besides his brains, secured a small lot and, of course, put up a drilling plant and started to drill a hole in the ground. His capital, however, was not as elastic as his spirit, and he was "up against it" before he reached the bottom, so much so that he lacked the cash to pay for the necessary sharpening of his tools. From one blacksmith to another he went to get his drill dressed, but they were all too busy with cash trade to bother with him. At last one took pity on him and fixed his drill, and shortly afterwards he struck a well flowing five hundred barrels a day, oil being worth from five to ten dollars a barrel. This was the beginning of his fortune, and he did not forget the blacksmith who helped him along. The early days of the oil fields are full of such cases as this one.

The wasteful extravagance of the early prospectors, who apparently drilled holes for the mere pleasure of seeing the oil flow away, produced its inevitable result. The supply of oil began to fail, and big discoveries were made at the older Petrolia field.

With the discovery of these new wells, such as the King Wells, in 1867, the excitement died down to a solid business proposition. The speculative period, such as is found in all mining camps, died out, and the oil men tackled the problem in a business-like manner. The price of crude oil now dropped to about twenty cents a barrel, but as an offset to this low price means were found of storing the oil, and gradually the great waste was stopped.

The Petrolia field proved much more stable than the Oil Springs field. The oil men learned economic methods and recovered from their original madness. Wells were drilled by steam power instead of the old kicking rig. This slide shows the outfit used at present for drilling. On the right is the steam engine that supplies the power to raise the drill. The drill hangs down the centre of the tall

tressel work that you see. By this means the hole is put down much faster and at considerably less cost per foot. The average time now consumed in drilling a well is about a week, and the cost a hundred dollars approximately.

It was found that the Petrolia field was much more extensive than was at first supposed, flowing wells were struck in all directions for a time. Railroads were built to connect with the new centre of activity, and petroleum refineries were built to handle the output. London was for a time the centre of this busines, which, however, was later transferred to Petrolia.

It was not long, however, before the wells ceased to flow and pumping had to be resorted to. This meant, at that time, that a separate steam engine had to be installed for every well. This method was so expensive that for years a well that was not good enough for ten or more barrels a day was abandoned as worthless.

Production, however, increased by leaps and bounds, and for years there was a big surplus in the thousands of immense underground storage tanks. The oil became almost a drug on the market. The production was still further increased by the discovery of a method of pumping a large number of wells from a single pumping station by means of "jerker rods." The rods were connected with a large wheel which made them jerk up and down, and this jerking motion was conveyed by means of triangles to a walking beam over the wells, which worked the pumps. In this way, to-day, as many as three hundred wells are connected up with one central pumping station. It's an odd sight in the oil district to see a perfect forest of tall tripod derricks, as many as five or six to a single acre, as far as the eye can see, each with its pump quietly working away with a slow steady motion and no visible source of power.

This discovery once again revolutionized the industry by so reducing the cost of operation that almost any pro-

ducing well was worth pumping. The production naturally increased and the price of crude oil remained low, and, for a time, there was not much prosperity in the oil fields on this account. However, the demands for all kinds of petroleum products grew with amazing rapidity, and within a few years all the surplus stores of petroleum were used up and the demands of the refineries could not be met, sufficient crude oil could not be produced. Every well that would give any supply was utilized ; the price of oil naturally rising with the increasing demand until to-day there are thousands of wells being profitably operated which do not average a third of a barrel a day.

It was very evident to all concerned that the supply of oil was gradually falling away, and the oil men lived in daily dread that it would cease altogether.

Again a new discovery came to their aid and a fresh impetus was given the industry. It was found that the detonation of a powerful explosive in the oil-bearing strata of rock at the bottom of the well produced a fresh supply of oil. After considerable experimenting it was found that nitro-glycerine gave the best results. With feverish energy, characteristic of the oil men, everyone wanted to have wells "shot" at once. Factories for the manufacture of this most dangerous fluid were established, and the first "glycerine men" grew very wealthy, as it was very cheaply made and sold for twenty dollars a quart.

The system of shooting a well was very simple, consisting merely in filling the well with water to hold the force of the concussion, then the nitro glycerine was lowered to the bottom of the well in long tin cylinders and exploded by dropping a fuse. A moment later a shock would be felt through all the 475 feet of rock and clay, and in a few seconds a fountain of water, oil and shattered rock would be hurled a hundred feet or more into the air.

The result of this is to so shatter the oil-bearing strata and open up the crevaces, that not only wells were made

doubly valuable, but dry wells frequently became producers. Another unlooked for result of the use of nitro-glycerine was the reviving of the Oil Springs' field, resulting in the making of another crop of rich men. In the previous rush to get away from Oil Spring, oil farms were abandoned or sold for next to nothing. Those who secured them were exceedingly fortunate. The wells were shot and at once became large producers, and the field took its place as a steady source of supply.

The nitro-glycerine trade is probably one of the most dangerous in the world, and big wages have always had to be paid the "shooters" who also made the chemical. Considering the carelessness of the men and the enormous quantities of the explosive used, very few accidents occurred. It is generally understood that with nitro-glycerine a man only makes one mistake. From time to time the factories blew up, generally with loss in life and nothing left to mark the place but a huge hole and few scattered remains of men and boards in the distance.

The petroleum industry seems to have been a very fortunate one. Some new discovery was always coming to light just at the right time. Again we have a discovery coming to its aid ; this time not a method connected with the production of the crude oil, but a method that made the petroleum of itself more valuable. The tarry residue, after the first distillation of the oil, was generally considered useless except as a fuel. An old oil man, by the name of John MacMillan, invented a process for the extraction of paraffine wax and lubricating oils from the residue. This immediately added to the value of the petroleum, as heretofore the tar had been wasted. This discovery made the tar almost as valuable as the illuminating oil, thus doubling the value of the crude oil.

With these various discoveries the oil business grew, and gradually a feeling of confidence in its permanency took possession of those interested in it. The fields were

extended in all directions till at the present time we have not only two fields, but many others, such as the Bothwell Oil Field, the Tillbury Oil Field and others.

Thousands were spent in prospecting and trying to open up new fields, while others grew rich by succeeding in locating fresh sources of supply in the old fields. To-day there are probably close on to 12,000 wells being pumped. Most of these, however, are small producers, not averaging more than a barrel a day, but with oil at its present price, $1.50 per barrel, and the reduced cost of operation, a man who owns a dozen or so of these wells is pretty well off.

The Dominion Government also gives the oil man considerable aid at present with a bounty of one and a half cents per gallon. In the year 1907 the government paid out in crude oil bounties the sum of $414,157.89.

To-day a well can be put down in a week at an expense of about one hundred dollars. Should it prove to be dry this is all that is lost, while if it is a producer another two hundred dollars will case it and install a pump. Once the oil is produced it is collected by means of tank wagons and underground lead pipes to tanks, whence it is delivered to the collecting agencies who give "warehouse receipts" for it and look after its subsequent delivery to the refineries. These warehouse receipts are what the producer has to show for his oil, and are sold by him as so much crude oil.

It is estimated that since the opening of the oil fields more than thirty millions of dollars have been invested in the producing trade, while many millions have been spent in refining and other lines of the enterprise. One peculiarity of the industry is that no sooner does a man make a few hundreds or thousands of dollars out of his wells than he proceeds to sink almost as much money back again into the ground.

For years the Canadian petroleum industry was heavily protected by a tariff. The present government, however,

gradually reduced this until a few years ago it was removed entirely, and in its stead a bounty of fifty cents per barrel was given the oil men. This has worked satisfactorily save for the fact that the Standard Oil Company has bought out the largest refineries and to-day is the greatest power in refining circles, thus to a large extent being able to dictate the price of oil. In justice to them, however, it must be stated that since they invaded Canada the producers have obtained better prices for their oil.

Thus far I have been giving you a historic sketch of the petroleum industry, and I shall now endeavor to describe to you the industry as it is carried on at the present day.

First, however, I would like you to get a clear idea as to just what petroleum is, what this oil, that has made so many men rich and so many poor, is. You will observe from the sample that is being passed around that it is a dark, oily looking liquid with a very disagreeable odor. It is slightly heavier than water, having a specific gravity of .88 or thereabouts. The disagreeable odor is due to the presence of a large percentage of sulphur in just what form we have not been able yet to determine. This is a sample of Canadian crude petroleum. It is readily distinguished from the American crude oil by the fact that the American oil has not disagreeable odor, it contains little sulphur. In the early days of the industry this made the American petroleum more valuable than the Canadian, as it was much easier to distill and refine on account of this sulphur. At present, however, the difficulty has been overcome and the sulphur does not offer any serious objection.

Crude petroleum, as it stands, is used quite extensively as a fuel. The International Harvester Works use a considerable amount in their forges and furnaces. The only preparation necessary for this class of work is filtering.

A considerable amount of scientific discussion has taken place as to whether petroleum owes its existence to

chemical action on mineral matter at a high temperature in the depths of the earth's crust, or whether it is formed from the decomposition of organic remains accumulated in sedimentary rocks. At present time the weight of evidence is in favor of the latter conclusion, but whatever its origin may be there are a number of conditions in respect to its source and surroundings which must imperatively obtain in order that an oil field of commercial value should be found.

It is necessary that not only should the original material exist in the locality in liberal quantities, but it should be accumulated into pools in such manner that when the bed is tapped oil will flow sufficiently free to be remunerative. To fulfil these conditions it has been found necessary that, over the rock containing the oil material and that containing the porous matter in which it may be held, an impervious dome-shaped roof of sufficient size and thickness be formed to prevent the escape of the oil under pressure during the ages through which it has been kept.

When the drill hole reaches the resevoir of oil, if there is a sufficient hydrostatic pressure under the oil, it is forced up and becomes a flowing well, otherwise a pump has to be used to get the crude oil to the surface.

The rocks of Southern Ontario, from Kingston to the River St. Clair, may be said to be composed of those formations belonging to the Upper and Lower divisions of the Silurian system. They are composed of a number of different formations from the Trenton in the east to the Hamilton in the west, the strata dipping in nearly a uniform manner towards the west, the outcroppings of the underlying strata appearing under the overlying drift clay at intervals along the route mentioned. In the uppermost of these strata are situated the petroleum beds on the summit of the anticlinal ridges parallel with the fields and sloping in either direction. The adjoining synclinal hollows in the rock being filled with a black shale, which

indicates to the operator that the limit of the producing field has been reached ; not that the black slate or shale interferes with the oil strata, but it indicates the existence of that part of the curve of the underlying dome which covers the portion of the strata containing only water.

The wells of Petrolia are sunk to a depth of 485 feet, and those at Oil Springs to about 370 feet, in either case penetrating the upper part of the Coniferous formation, which in these localities is composed of a porous dolomitic limestone filled with petroleum, underlaid with a strata of water under considerable pressure which assists in forcing the oil out of the pores of the rock into the bore of the well whence it is pumped to the surface.

In sinking wells to these depths, several strata of shale and limestone are penetrated, some of which are friable, or contain water, in which case iron tubing is introduced into the drill hole and the objectionable matter excluded and the work proceeded with. In every case an upper strata containing oil is found in the Petrolia region, which is utilized. At Oil Springs, however, an immense accumulation of oil was found in the overlying strata at a depth of about 150 feet, but completely separated from "lower vein" and connected with a water pressure sufficient to raise the oil with great force to the surface, from which were derived the flowing wells of 1862.

The operation of sinking a well essentially consists in the rise of a heavy bar of iron provided with a chisel pointed extremity and attached with rods and cables to power machinery, which alternately raising and dropping the chisel cuts and pounds the rock into fine particles, which are removed from time to time by passing a valved tube to the bottom of the bore where it is filled and drawn to the surface.

A careful log or record of the wells is kept, that is a record of the different strata, etc., through which the drill

passed in reaching the oil-bearing strata. The following is the log of a typical well in the Petrolia region :

Surface clay	100 feet
Top rock	50 feet
Soapstone	134 feet
Middle lime	15 feet
Lower soapstone	44 feet
Depth to lower lime	343 feet
Lower lime	145 feet
Total depth	478 feet

One hundred and ten feet of 4⅝ inch casing used. Shot 15 quarts of nitro-glycerine.

On the completion of a well it is cased to carefully shut off surface and other water. A charge of nitro-glycerine is exploded at the bottom of the well to open up the pores of the rock and clean out the debris caused by drilling.

A pump is introduced and connections made with a vibrating rod attached to a jerker constructed to pump a number of wells, in some cases from 20 to 80 wells or more being run from one set of machinery.

Small pipes are laid to each well to conduct the oil to the central tank for delivery to the pipe line companies, who draw the oil from the receiving tanks and store it in their store-house tanks or transmit to the refiner.

The oil is nearly all conveyed to its place of final disposal through underground pipes, by steam power generated with the fuel formed from the refuse from the material handled.

One of the necessities, from the want of which the early oil operators suffered, was tanks in which to store their oil pending the season of the year in which the bulk of it would be required. Naturally the Canadians erected, in the first place, great wooden tanks which increased in

time to enormous proportions, some being as large as 24 feet in diameter and 20 feet deep. Large iron tanks were introduced in 1865, two of which had a capacity of 3,000 barrels, and these still remain as mementos of the time. The iron tanks, however, were found to be too expensive, and they subjected the oil stored to many sources of danger, and vast improvements were found practicable and of such a nature as no other part of the world has been known to supply. The Erie clay, found in this region, would almost appear to have been supplied for the express purpose of oil storage. This clay is of a solid, tenacious quality, free from seams or flaws, and easily removed. When properly constructed tanks are sunk therein they are cool, perfectly free from danger of loss by leakage or evaporationer destruction by fire.

The tank is formed by excavating a circular hole about thirty feet in diameter to a depth of about fifteen feet through the top soil, Saugeen clay, which is somewhat porous. A wooden crib is placed therein formed of double inch rings five inches wide, outside of which boards are nailed and the clay from the strata below is solidly packed between the curbing and the wall making a solid puddling about five feet thick. The sinking of the tank is then proceeded with to a depth of fifty or sixty feet, the entire wall is lined with segments made of inch pine about five inches wide forming a perfectly tight tank holding from 8000 to 10,000 barrels of oil, which on saturating the wood renders it exceedingly durable. Timbers are laid across the top supported by a block from the arch over it, joists are laid thereon, covered with planks and clay and the contents rest in perfect safety until required.

After the crude oil has been obtained a process of separation of its parts and removal of its foreign impurities must take place to render it fit for use. Petroleum as it comes from the ground is composed of a series of hydrocarbons ranging from the lightest gases to the solid waxes.

To separate these from each other three independent principles are applied.

First the crude oil is placed in a still or retort and gradually heated and vaporized, the vapors pass through the condensing pipes and the resultant fluid is divided at several stages into the parts required, as volatile benzine or naphtha, kerosene or coal oil, the intermediate or gas oils and finally a mixture of crystallizable and heavy oils. The temperature to which the retorts are raised determines what oil will be produced. As the temperature rises the more volatile compounds come off first, that is naphtha, then the others in rapid succession.

Between O degrees Centigrade and 150 degrees naphtha is obtained, from 150 to 300 illuminating oils, above 300 degrees the heavy lubricating oils and waxes, and lastly coke.

Second of the three principles applied. The heavy oils are divided into paraffiine wax on one hand and lubricating oils and vaseline on the other, by passing the mixture through a freezing process and subjecting the chilled mass enclosed in stout linen bags to an immense pressure when the liquid parts flow out and the wax is retained.

The third principle, is the further purification of the respective parts by repeated washings with chemicals, the chief of which are sulphuric acid, lye, lead oxide which combine with and remove the offensive impurities, such as sulphur.

Such are the methods employed to prepare the products for general use, but the application of them to the best advantage has required much investigation, experience and outlay. The solution of many problems have eluded the most persistent of those who have spent years of labor and thought on the subject and have only within the last few years succeeded in producing results which enable the refiner of Canadian crude oil to remove those objectional impurities which pertain to all oils drawn from the old geological formations.

The illuminating oil having been prepared is for the most part filled into barrels coated with glue on the inside and painted outside or into car tanks and is then inspected by the Excise officer to see that it is free from dangerous gases, the other qualities of the oil being under very little regulation.

The crude oil is thus shipped to the consumer in a great many different forms :—gasoline, naphtha, coal oil, lubricating oils, vaseline of various grades, axle grease, paraffin wax and so on. Indeed it is difficult to imagine how the people that lived in the early part of the century were able to get along without these articles which we have now looked upon as necessities.

New Zealand

BY LYMAN LEE, B.A.

Read before the Hamilton Scientific Association, May 7th, 1908

In conversation with a prominent member of this Association some time ago, we came to the conclusion that it would prove of educative value to the members if we could have a series of papers on the various parts of the British Empire, and we both came to the decision that New Zealand was perhaps the most interesting colony on which to make the first experiment. I have never visited this colony. My information is all derived from books. In fact, this paper is chiefly a compilation from an interesting and important book written by Prof. Frank Parsons, a lecturer in the Boston University School of Law, and called "The Story of New Zealand," and being a history of New Zealand from the earliest times to the present with special reference to the political, industrial and social development of this Island Commonwealth. This book was written in 1904.

New Zealand consists of three islands, two large and one small. Taking the islands as a group they are a little larger than Great Britain. Their extreme length is about 1000 miles running almost north and south. They extend from the 35th to the 48th degree south latitude.

A range of mountains extends along the western coast of the middle island. There are ranges of lofty mountains in the central part of the northern island and a number of volcanic peaks, some active and some extinct. In this middle region of the northern island there is a district about 30 miles wide and 100 miles long, which contains many hot springs, geysers, pools of boiling mud, volcanic

cones and other manifestations of the under-world. Clouds of steam and sulphurous fumes rise from the boiling pools, and there are rumblings in the earth which show that the central fires come close to the surface there.

The coast-line is irregular, many of the bays affording excellent harbors, and along the south-west coast of the middle island is a series of sounds indenting a mountainous coast, and surpassing in beauty and grandeur the famous fiords of Norway. Rivers and waterfalls abound, and many glaciers glisten among the peaks of the snowy range. Noble forests fringe the coast of the nothern island, and broad, rolling plains are a striking feature of the middle island; rivers and lakes abound, and the whole scene which meets the eye of the traveller is full of brightness and beauty. Geologically New Zealand is one of the oldest portions of land now forming any portion of the earth's surface. It has been repeatedly submerged and upheaved, and contains excellent deposits of coal, iron, gold, silver, copper, chrome, graphite, lead, mercury, mineral oils, sulphur, and zinc, besides limestone, granite, marble and other building stones.

A little over 500 years ago the Maoris, a savage people from the Islands of Polynesia, arrived at these islands in their double canoes. A double canoe consists of two canoes joined by a structure or platform across the top of each. By means of such canoes these daring and enterprising people became the greatest navigators known until the century of Columbus. They were a brown people, fair-sized, heavily built, strong and athletic. They found the country inhabited by aborignees, of which we know very little. It is generally understood that the Maoris ate them up.

In 1642, Tasman, a Dutch Sea Captain, sighted the islands, anchoring in what is now called Golden Bay, near the north-west point of the middle island. He tried to land, but gave up the attempt on account of the hostile

attitude of the natives. He was the first white man to see these islands, as far as we know. He reported his discovery when he returned to Holland and the Dutch authorities named the new country New Zealand, that is New Sea-land.

Nothing further seems to have been known about this country until a century and a quarter later when in 1769 Captain Cook came in "The Endeavor" and landed on the northern island at Poverty Bay, where the town of Gisborne is now situated. He was the first white man to set foot upon New Zealand soil. He shot a few of the natives who opposed him, and they returned the compliment by killing and eating the entire crew of his companion ship "The Adventure." For the most part, however, his relations with the natives were pleasant. He gave them some seed potatoes and the seed of cabbages and turnips, and turned pigs and fowls loose to furnish them with meat. From these pigs are supposed to have come the wild pigs that are still shot in the forests. He sailed entirely around the group and passsed between the northern and middle islands through what is now called Cook's Strait. He again visited the islands in 1773, 1774 and 1777. He wrote an interesting account of his observations which attracted much attention. After that whalers and traders began to visit the new country, and in course of time a few settlers came and started the building of a colony.

It is a curious fact that, at that time, this land was almost entirely devoid of animal life, except in the sea and air. Fish were plentiful and in great variety, and the same may be said of birds. There were no mammals except two species of bat; no dogs, sheep, cattle, horses, wolves, squirrels, rabbits, no wild beasts, no snakes, no venomous reptiles or insects. It must not be inferred, however, that conditions in New Zealand are in any way unfavorable to the existence of animal life; on the contrary both domestic

and wild animals that have been introduced there have multiplied and thriven in a remarkable degree. For example, sheep flourish so that mutton and wool have long been two of the leading exports ; and rabbits multiplied so rapidly that they became a pest, and farmers had to fight them with traps, poison and barbed wire fences, but now they are turned to some account by exporting by the shipload their dressed bodies in a frozen condition to England. Many excellent varieties of timber trees, such as beech, pine and cedar, are found in the forests. Flax is a native plant, from the fibre of which the Maoris made blankets and clothing. American and European cereals, vegetables and fruits have been introduced, and they flourish remarkably. The water-cress, introduced by accident probably, increased so fast that it threatened to choke half the streams. The sweetbriar, another invader, grows tall enough, it is said, to arch over the head of a man on horseback, and has extended its domain so rapidly that it has become one of the principal vegetable pests of the country. The resin of the Kauri, a native gum tree, is one of the chief exports. It is used in the manufacture of oil varnishes and also as a substitute for amber. Insect life is less prevalent than in Europe or America.

During the early years of the nineteenth century whaling and trading vessels came in increasing numbers, but no event of importance occurred till the arrival of the missionaries in 1814. It became known that the Maoris were a very superior race of savages and thus attracted Christian missionaries. The leader of these was Samuel Marsden, the Chaplain of New South Wales. The apostle to the Maoris was a plain, unassuming, kindly man, who made no claim to scholarship, brilliancy, wealth or rank, but had a practical knowledge of human nature and earnest zeal.

While returning to Sydney from a visit to England in 1809, he noticed on the ship a brown-skinned ragged man,

whose forlorn condition awakened his sympathy. Sick and weak and racked with a violent cough, the poor man seemed to have but a short time to live. Marsden did his utmost to care for him, and through his kindness and help the man recovered with a life-long gratitude in his heart to the loving missionary. This brown man was young Ruatora, a Maori of high rank and a relative of two famous chiefs, Te Paki and Hongi. He was returning from a five year's cruise in which he had been badly treated by whalers and shipmasters. He stayed six months in Marsden's house in Sydney, when he went back to New Zealand with some seed wheat and a considerable knowledge of agriculture. The wheat, which was given to the chiefs by Ruatora and sown, converted into bread and eaten before the chaplain put his foot on the soil, was a great factor in preparing the savage mind to listen to the missionary. The missionaries took with them a horse and some cattle, sheep, goats, pigs and poultry. From the missionaries the Maoris learned better methods of agriculture, and various simple arts and handicrafts, and schools were opened for their instruction. A little later, with the aid of philologists in England, the missionaries reduced the Maori tongue to a written language which the natives had not before possessed, and translated the scriptures and other works into Maori.

By the year 1840 about one-fourth of the Maoris were converted to Christianity, and the conversion was so true that they earnestly opposed cannibalism, slavery and tribal warfare, although these institutions were all deeply embedded in the habits and traditions of their race. The progress of missionary work since 1840 has been very great. During a period of fifty years no missionary lost his life by the hand of a Maori, and during that time the race was changed from cannibalistic savages to Christians. They voluntarily liberated their slaves without compensation or reward. Before their conversion to Christianity, in spite

of their cannibalism and incessant tribal wars, the Maoris were one of the finest races of savages that have been found. They held their land in common as the property of the tribe, and agriculture, fishing and fowling were the work of the community for the benefit of all.

In the wars with the whites in 1843 and 1845, and almost continuously from 1860 to 1870, the Maoris fought with courage and vigor. But they have long since given up cannibalism and war. For over 30 years they have been peaceful, law-abiding citizens. Both their men and women are voters, six of the race are members of parliament, four in the House and two in the Senate, and one is a member of the Cabinet.

The first attempt to form a settlement in New Zealand occurred in 1825, but it failed on account of the savagery of the natives. In consequence of frequent visits of whaling vessels to the Bay of Islands, a settlement grew up there, and in 1833 Mr. Busby was sent there as British Resident. A number of Eurnpeans, generally men of low character, gradually settled in different parts of the country and married native women. In 1839 a New Zealand Company was formed in England for the purpose of colonizing New Zealand, and its first body of emigrants landed in 1840, and this settlement has now become the City of Wellington. From this time on settlements gradually increased in number and in size, but there were many difficuties with the natives, particularly concerning land titles. In 1861 rich deposits of gold were discovered, causing a rush and sudden increase of the population. In 1840 the white population numbered about 2,000 and the Maoris something like 60,000. In 1853 the whites were 30,000 strong. In 1857 the natives and whites were about equal in numbers. By 1874 the whites numbered 299,154 and the Maoris only 45,470. In 1906 the whites numbered 888,578, and in 1901 the Maoris 47,731.

In the early days the traders and settlers desired the

protection of Great Britain, and the friends of colonization in the British Isles were anxious that Great Britain should take charge of New Zealand as a British Colony. The missionaries, on the other hand, opposed annexation at first because they feared its effects on the natives and their conversion. The strong influx of Europeans likely to follow annexation, with the saloon, gambling den and other accompaniments of the early influx of Europeans, and the cruel wars almost certain to result from the rapid settlement of a country full of savages, were not calculated to advance the interests of Christianity. Savagery and cannibalism were sufficient obstacles without the white man's amusements and conflicts of trade and conquest. The British Government not only regarded the opinions of the missionaries as entitled to special consideration, but had a further reason for being at least rather cool with regard to taking New Zealand under the banner of the Empire. When the friends of colonization sent a deputation in 1829 to the Duke of Wellington, their Prime Minister, to urge the acquirement and settlement of these islands, the Duke said Great Britain had colonies enough. John Bull's appetite for land was not as keen just then as usual. For years this feeling and the opposition of the missionaries kept the British Government from doing anything except sending James Busby to the Bay of Islands in 1833. He was able to accomplish very little notwithstanding all his efforts to establish some sort of stable government.

Fears of French colonization and the "land sharks" were, however, powerful factors in hastening British colonization. The "land sharks" bought large tracts of land for speculation. Many of the purchases were imperfect or fictitious. Boundaries were inserted by purchasers after the deeds had been signed in blank by the sellers. The same land was sold three or four times. Some purchases were airily defined by latitude and longitude.

Almost the whole area of good land in the middle island was the subject of one professed sale. An Australian politician, Wentworth by name, "bought" ths island at a single stroke from nine wandering Maoris, picked up on the streets of Sydney, who had no right to sell any part of the alleged "purchase." The "Wentworth Syndicate" paid them a little over $1,000, or at the rate of about one cent for each 200 acres of the area claimed.

By 1840 it was estimated that, exclusive of this middle island claim and the claim of the New Zealand Company, which I shall refer to in a moment, 26,000,000 acres or more than a third of New Zealand had been acquired by the "land sharks," a large portion of it having been bought several times over from the Maoris by different purchasers. Including the Wentworth and New Zealand Company claims, the total purchases amounted to 82,000,000 acres, or 16,000,000 more than there were in the whole country, including snow-capped mountains, glaciers and pumice plains. Some strong authority was clearly needed to deal with the conflict of titles, disputes with the natives and other evils growing out of this land monopoly. The New Zealand Company, under the leadership of Gibbon Wakefield and his brother, Col. Wakefield, were determined to settle New Zealand whether the British Government sanctioned it or not. In September, 1839, the Colonel made extensive land purchases for the Company, at least he thought he did, and the Company claimed twenty millions of acres north and south of Cook Strait in what are now the Wellington, Taranaki and Nelson Districts. Fifty-eight chiefs signed the deeds of sale, receiving a lot of muskets, powder, axes, blankets, pipes, tobacco, looking glasses, soap, shaving boxes, handkerchiefs, jew's harps, calico, scissors and other goods amounting to $45,000. The Maoris probably knew the sale was a fraud, at any rate they had no right under Maori law or custom to alienate the heritage of the tribes. Very likely most of the

chiefs did not understand how much land the Colonel thought he was buying, and did not have any notion of selling the vast area claimed by the Company. At the time, however, the Company did not appreciate the difficulties of land purchase in New Zealand, and relying upon the Maori deeds they organized a body of colonists and landed them in January, 1840.

The settlers and traders and land sharks, the menace of French interference, the change of heart among the missionaries and the presence of the New Zealand Company at last induced the Colonial Office to annex the islands. In 1839 a royal proclamation was issued, extending the political boundaries of New South Wales to include any territory that might be acquired by Her Majesty in New Zealand, and Captain Hobson arrived at the Bay of Islands January 29, 1840, with a commission as Lieutenant Governor under the Governor of New South Wales. The history of New Zealand as part of the British Empire dates from that day. The royal proclamation covered only such territory as might be acquired in sovereignty by the Queen. On February 5th, 1840, a week after Hobson's landing, the northern chiefs were gathered in conference at Waitangi and the question of British rule laid before them. The result was the Treaty of Waitangi in the following terms:

1st. The chiefs of New Zealand ceded to Her Majesty, absolutely and without reservation, all their rights and powers of sovereignty.

2nd. Her Majesty guaranteed to the chiefs and tribes of New Zealand full exclusive and undisturbed possession of their lands and estates, forests, fisheries and other properties; but the chiefs yielded to Her Majesty the exclusive rights of pre-emption over such lands as the proprietors thereof might be disposed to alienate at such price as might be agreed upon.

3rd. Her Majesty gave the natives of New Zealand all the rights and privileges of British subjects.

About fifty chiefs signed the treaty then and there, and in six months it had been signed by 512. Only one chief of first rank refused to sign. Te Heu Heu, who lived in the volcano plantation near Lake Tuapo, in the plateau in the middle of the north island. His tribe was simply let alone until their opposition vanished. For the rest, the Maori race accepted the Treaty of Waitangi, and well they might, for while the supreme political authority passed to Great Britain, the ownership of their lands was guaranteed to them and to this day they regard that treaty as the Magna Charta of their liberties. Some 60,000 or 70,000 Maoris were secured in their title to nearly 66,000,000 acres of valuable land.

British Sovereignty over the north island was proclaimed May 31st, 1840, and over the middle or south Island, as it was then called, on the 17th of June 1840.

In September 1840, the Governor established his residence at Auckland and it became the capital. For 24 years it held this honor and then the seat of government was transferred to Wellington on account of its central position, but Auckland is still the first in size and beauty and second to no other New Zealand city in prosperity and progress.

On May 3rd, 1841, New Zealand was declared independent of New South Wales with Hobson as Governor. He established effective government and had excellent laws passed for the administration of justice and the regulation of property and civil rights. In this he was materially aided by his attorney general, William Swainson, an English lawyer of fine ability and remarkable freedom from slavish subjection to precedent and technicality. He framed the laws of the infant colony in simple, concise and intelligible language, and swept away many cumbrances English precedents and technicalities in conveyancing, legal procedure, etc.

The most important matter which Governor Hobson

and his council had to deal with was the land question. Under the Treaty the Crown had the first right of purchase from the Maoris. The justice or injustice of the claims of pretended purchasers from the natives was in every case inquired into very carefully and right was done as far as possible. The New Zealand Company's claim was cut down from 20 millions to 283,000 acres.

Governor Hobson died September 10th, 1843, He had done his very best under most trying circumstances and was universally respected.

Among the important factors in the early history of New Zealand, a leading place must be assigned to the ideas and doings of Gibbon Wakefield, the founder of the colony and George Grey its greatest Governor, author of its constitution and pioneer leader of what is called the Liberal movement.

Gibbon Wakefield established the system and organized and directed the company under the auspices of which three quarters of New Zealand was colonized. His dominant idea was "scientific colonization" careful selection of emigrants, inducements to laborers and capitalists to go to the new country in organized groups and sale of the land under free selection at a uniform "sufficient price" that is, a substantial price sufficient to prevent speculation and secure close settlement diversification of industry and funds for emigration and public works. Instead of making colonists out of convicts and treating a colony as a sort of vacant lot on which to dump the refuse and waste of older countries, Wakefield believed in choosing colonists morally and physically worthy to be the founders of a new commonwealth. In those parts of the colony where he operated the high character of the settlers, the rarity of crime, the good standard of education, the evidences of intelligence and even of refinement have always been obvious enough to strike even very hasty observers. In an evil hour however, Captain Fitzroy, the second Governor waived

the Crown's pre-emptive right in March 1844, and permitted private purchase from the Maoris, subject to the approval of the Government and the payment to it of 10 shillings on each acre which was soon reduced to 2 cents an acre. This was an evasion of the Land Sales Act of 1842 and the breaking down of the barriers established by the Treaty. Fitzroy yielded to the clamor of speculators and by his weak vacillating policy brought on sullen discontent among the settlers and war with the natives. His administration culminated in conflict, financial paralysis and general confusion.

Fitzroy was recalled and Captain George Grey was placed at the head of the colony November 1845. At last New Zealand had a real statesman at the helm ; a man of strength, high character and resource, a gentleman, courteous and tactful, a lover of the people, a commander of ability, a governor of remarkable power and a statesman of exalted purpose. He speedily ended the war, and not only conquered the Maoris, but won their admiration and their love. He protected their rights and had ordinances passed to prevent the sale of liquor and munitions of war to the natives. He subsidized native schools, provided savings banks and established hospitals and other charitable institutions. He constructed trunk roads by military and native labor. He repealed Fitzroy's land regulations and enforced the Crown's pre-emptive right. He induced the natives to sell some millions of acres in the north island and nearly all the middle island whereby the Government acquired a large estate that laid the basis for real progress. In purchasing land from the natives for the State he introduced the system of paying the money in instalments, spread over a series of years. This kept the natives from reckless dissipation and served as a security for their good behaviour.

The greatest of all the many services rendered by Governor Grey in his first administration, which lasted

until the end of 1853, were his resistance to two unjust acts of the Home Government consisting of a violation of the land clause of the treaty of Waitangi and an unfair constitution and the establishment of representative government on a just basis. He found the colony on the brink of ruin and left it in a state of prosperity and progress, and although just at the end of his first term he made the mistake of reducihg the price of public land from £1 to 10s. and under certain conditions to 5s. an acre, which led to the purchase of enormous territories by runholders, speculatars and monopolists and the locking up of large estates in few hands. Yet his motive was excellent, even in these cheap land regulations which he intended to enable poor men to get farms, not forseeing the speculative purchases and in spite of this mistake the Colony owes to Earl Grey much that is best in its history.

The New Zealand Company and its settlers at Wellington, Auckland, Nelson, etc., were continually agitating for representative government and in August, 1846, the British parliament enacted a constitution for the Colony. But it was ill-made and wholly unjust to the Maoris, who far out-numbered the whites, and who by the Treaty of Waitangi had been guaranteed all the rights and privileges of British citizens, yet were practically excluded from any share in the government by the proposed constitution and the instructions sent with it. Sir George Grey with a moral courage and good sense, which did him great honor, succeeded in postponing the enforcement of this constitution for several years until a just and reasonable, and at the same time practicable one could be adopted. In 1852 Britain sent over the seas another constitution affording substantial self government, and leaving the right to vote open to Maoris as well as white men. It established a central government and six provincial governments, the lower House in each case being elective under a franchise based on a property qualification.

The central government consisted of a Parliament and and a viceroy or governor, appointed by the Colonial office to be commander in chief of the Queen's forces in the Colony with the power to appoint such persons as the Crown might desire to be members of the Legislative Council or Upper House of Parliament, to dissolve Parliament at his pleasure and to reserve bills for the consideration of the Home Government. Though much in evidence in the early years, the Governor has long since ceased to be active. From 1868 the real executive has been the Prime Minister of the Colony and his Cabinet and the Governor has become a figurehead which the Colony pays for. The central legislative power was placed in a General Assembly, consisting of the Governor, the Legislative Council (or Senate) and the House of Representatives. The Upper House was composed of such persons, not less than 10, as the Governor under the Queen's authorization might summon and they were to hold their positions for life. The tenure now is 7 years and these appointments are now made on the recommendation of the Prime Minister and his cabinet. The total number of the Upper House now is 44.

The House of Representatives is elective, only men having a certain property qualification and residence were under the Constitution allowed to vote or become members of this House, and the Parliament was for a five year term unless sooner dissolved by the Governor; but all these provisions were subject to change, and have been changed. No property qualification is now necessary to a vote, and both men and women have that right. The parliamentary term is now only three years. Since 1902 there have been 80 members in this House, 76 European representatives and 4 Maoris.

The General Assembly may make laws "not repugnant to the law of England," with a few specified exceptions relating to duties on military imports, exemptions, bounties, drawbacks or other privileges in respect to any imports or

exports and charges on shipping at variance with treaty between Great Britain and any foreign power. The Governor was given power to reserve Bills passed by the New Zealand Houses for consideration by the Home Government. But during the history of half a century of vigorous legislation, including some of the most radical measures the world has ever known, experience proves that Great Britain is inclined to use this power very sparingly. New Zealand is practically independent, except in respect to international matters, and the little liberty she yields is vastly more than compensated by the benefits of federation in the British Empire.

The first parliament met in 1854 at Auckland. The first session was stormy and lasted only for a few weeks. Those who had drawn up the constitution had neglected to provide for a responsible ministry, that is a ministry that could be brought to an end by vote of the House. A bill was, however, passed for the establishment of a ministry responsible to the House, and it received the consent of the Home Government so that when the second Parliament met in 1856 it took control of the Cabinet. When Sir George Grey retired from the Governorship in 1868, the real executive power passed to the ministry where it has remained ever since. From about the middle of December, throughout January, February and March, which are the summer months in New Zealand, Parliament does not sit. Most of the important laws are passed toward the end of the session in September, October and November.

Having traced briefly the history of this interesting part of the civilized world up to the inauguration of responsible government, as it is impossible for me to give any detailed account of the extensive radical and progressive legislation of the Parliaments of New Zealand in this paper, I must content myself with briefly indicating the character and scope of a small part of such legislation.

The Torrens System of land transfer has been gradually introduced with most satisfactory results. The

post office, in addition to all the services we have, carries on a parcel post business and the rates charged are said to be less than half the charges made by our express companies for similar services; and the telegraph and telephone are operated as public utilities by the Government. Mr. Gladstone secured the establishment of the postal savings banks in England in 1861, and four years later New Zealand adopted the new idea, and since then almost every country in the civilized world, except the United States, has followed their example. In New Zealand in 1904 there was a place of bank deposit for each 1,800 people, and the total deposits in all sorts of banks was $140 for each inhabitant as compared with $110 in the United States and $125 in Great Britain. The nation also owns and operates almost all railways. After an experience of over 30 years the statesmen and people of New Zealand, rich and poor, Liberal and Conservative, are substantially a unit in favor of national railways, and no proposition to turn the railroads over to private corporations would stand the slightest chance of acceptance.

In 1870 a Government Life Insurance Department was established. The Department was popular from the start. From the report of 1901 it appeared that there were then in force 42,570 Government policies covering $51,000,000 of insurance, or practically half the whole insurance business of the colony. The government office has beaten the private companies in fair competition. The government bureau employs paid canvassers, has handsome offices and issues attractive and skilfully worded circulars and advertisements to invite the patronage of the people. The government rates are lower than the premiums charged by private companies, but the main elements of competition are in the conditions in and behind the insurance. The people prefer the government insurance not only because of its cheapness, but because of its safety—the guarantee of the government behind it and its freedom from all oppres-

sive conditions, and, in fact, from practically all conditions of any sort. The conditions appear to be that the premiums must be paid and the assured must not commit suicide within six months after the insurance is taken out. The policy is world-wide. "The assured may go where he will and do what he likes, get himself shot in battle, smoke cigarettes, drink ice water and eat mince pie, or commit suicide in the ordinary forms after six months and the money will still be paid to his relatives." Even the condition as to the payment of the premiums is not the cast-iron arrangement it often is with us. If a man fails to pay the department his premium when it is due, he does not lose his insurance. The government pays the premium out of the surrender value of the policy, and will do this over and over again as long as there is any surrender value left. The system is entirely co-operative. The profits of the business goes to the insured. They are divided triennially. In five divisions of profits the total returned to policy holders was about $35,000,000. There is a temperance section established in 1882 in which total abstainers are insured in a group by themselves—a mutual society of non-drinkers with their own bonuses. The government will loan money on the policies at 6 per cent. below $500 and 5 per cent. beyond that sum. The funds of the department are invested in mortgages on real estate, municipal bonds, good securities and loans on policies. The department is free from any taint of the spoils system, and even the competing private insurance companies admit that it is well managed. Experts are in charge of the business and they have made it a complete success.

A large portion of the advanced legislation of the Colony has been enacted since 1890.

Under the Land and Income Assessment Act of 1891, and amendments thereto, the property tax is abolished and a graduated taxation of land values and incomes established. The avowed objects of the law are "to tax according to

ability to pay," "to free the small man" and "to burst up monopolies," and its cardinal features are the exemption of improvements of small owners and traders, and the special pressure put on the big monopolists and corporations and on absentees. One of the great objects of the law is to make it expensive and unprofitable to hold land in large tracts for speculative purposes. The land system of the country has been greatly effected with the ideas of nationalization of the soil, leasing in perpetuity restriction of area and of transfer, resumption and division of overgrown estates, abolition of large holdings, close settlement under improvement and residential conditions, co-operative development of small farms, settlements, suburban homes for workingmen, easy access to the soil for all, especially for those of small means, preference for the landless, gradual absorption of the unearned increment for the use of the public—the land for the people in every way and not for the few. There are three ways of overcoming land monopoly: (1) Confiscation. (2) Pressure through taxation, etc. (3) Resumpiion or state purchase by agreement or compulsion. New Zealand, while using the second, relies largely on the third, which meets the need more definitely and certainly than any ordinary tax and more justly than confiscation. To meet the demand for land and break up monopoly, favor the settlement of men of small means and move toward the nationalization of the soil, the Ballance Ministry in 1890 agreed on the policy: (1) Of putting pressure on the large holders through progressive taxation. (2) Of conserving the remaining public lands for genuine settlement. (3) Of limitation of the area of holdings and of the right of transfer. (4) Of repurchasing and dividing large estates, and (5) of establishing the true perpetual lease (with periodic revaluations and no right to purchase the freehold), as the tenure on which public lands and resumed lands should be taken.

The first of these aims was accomplished in 1891 and

1892. The second, third and fourth were carried out by the land acts of 1892 and 1894, but the fifth was compromised after an earnest fight—leases in perpetuity (999 years) with no right of repurchase and no revaluations, leases for 25 years, with right of purchase after 10 years and the optional system with residential and improvement conditions, being accepted by the government in place of the desired perpetual leases in order to carry the other provisions of the land acts. The legislation secured, though not up to the ideal of its promoters, was nevertheless sufficient to turn the tide from concentration to diffusion of the ownership and benefits of the soil, and win the victory for the people in the great battle between the settlers and the monopolists, which has been going on since the foundation of the colony. The Land for Settlements Act, of 1892, authorized the Governor to acquire any land by contract with the owner, to be disposed of in lots not exceeding 320 acres and only in lease in perpetuity at 5 per cent. rental, whether it was rural, suburban or town land. Other resumption clauses were contained in the Land Act (1892). But the lack of compulsory power made the working of the law quite unsatisfactory. Nearly a million acres were offered under it to the government in 1893, but much of it was poor and unsuitable and the price asked for the rest was usually excessive. It was not till 1894 that the principle of compulsory purchase of large estates was enacted into law, and the Ministry had effective means of carrying out their purposes.

A "prescribed maximum" area is fixed by the law in respect to each class of land, and a much smaller maximum in the case of land within five miles of a city. If any person or company has more than the prescribed area the government can take, by compulsory process, the excess above the prescribed area or the whole block, if the owner does not want it divided.

The lands acquired by resumption must be divided and cannot be disposed of by sale, but only on lease in

perpetuity. The rent is 5 per cent. on the land value, as estimated at the beginning of the lease, and if at any time for sufficient cause the lessee is unable to pay, the Minister may remit a year's rent. The Consolidation Act of 1900 empowers the Commissioner of Crown Lands and the Receiver of Land Revenue to grant at their discretion to any tenant not in arrears a rebate of 10 per cent. on any installment in order to encourage punctual payments. Where tenants take lands with buildings thereon they have to buy the buildings by half-yearly payments extending over a term of years, and in the meantime pay interest on their value at 5 per cent. The profit to the government from land repurchase has been large.

Before 1890 the tide of population was from the country toward the cities, but the land policy has turned back the movement of the people toward the soil. The holdings have increased over 60 per cent. Instead of one man in four being the holder of farming lands, as was the case in 1892, in 1904 one man in two was the holder of rural lands. Many of the comparatively poor have been the chief gainers by the land policy. In the year 1894 the Government Loan Office was established through which public funds are loaned to farmers, laborers, business men, etc., and at low interest and on easy terms. The situation in the early nineties naturally led the people and their representatives to look to government lending as a means of relief from and protection against excessive interest and unreasonable conditions. In spite of falling prices and industrial depression the banks and money-lenders would not reduce the rates of interest, but rather increased them. The farmers' income was diminishing whilst his interest was increasing. In this predicament it occurred to him that the Government, his Government, the great firm in which he had an interest which could borrow money at 3 or 3½ per cent., could lend money to him at a more reasonable rate of interest. A law therefore passed author-

izing the loaning of money on freehold or leasehold interest cleared of encumbrances and free of any breach of condition. The loans are secured by first mortgages of lands and improvements. No loan can be for less than $125 or more than $15,000, and the sum of the advances to any one person must not exceed $15,000. The interest ranges according to the terms of repayment, from 4½ to 5½ per cent. with an increase of ½ per cent. if payment is not made promptly.

In 1892 a law was passed to get rid of the difficulties, injustice and expense caused by legal decisions based on technical defects. Cases are under this law decided on their merits, and no man loses his rights because of any technicality.

The electoral reforms so earnestly advocated by Ballance, after being twice wrecked in the Upper House were adopted in 1893. These reforms embodied the one man one vote principle, equal suffrage for men and women and compulsory voting. Under the compulsory voting provision if an elector, who is not a candidate at a general election, nor prohibited by law from voting fails to vote, his name is expunged from the voting list and unless he appears and excuses the neglect to the satisfaction of the Court he loses his vote at the next election. At the first election at which women were entitled to vote held in November 1893, 90,290 women voted and 129,792 men. At the election of 1899, 119,550 women and 159,780 men went to the polls, 71 per cent. of the women of the Colony and 75 per cent. of the men. In 1902 about 95 per cent. of the women were enrolled and 75 per cent. of those who were registered voted. There is not even a whispered suggestion to repeal the law giving women the suffrage.

New Zealand is the land of the eight-hour day. This does not mean that everybody works eight hours, but a very large part of the laboring classes have the eight-hour day and from one end of the Colony to the other, eight

hours is recognized as the standard working day, both in public and private service. This is due to the combined force of industrial organization, public opinion and law. Legislation in almost all lines is of a very advanced character and it would be a genuine pleasure for me, were not this paper already too long to deal with many phases of of same but I must content myself on this occasion by giving you some idea of the introduction and achievements of industrial arbitration.

New Zealand is the first country to abolish strikes and lockouts and establish judicial decision of labor difficulties in the place of industrial war. This was accomplished in 1894. The law then enacted enables either party to an industrial difficulty to bring the matter into court and have it decided by an award with the binding force of a judgment of the Supreme Court, a law that has put an end to the battles between capital and organized labor and has produced continuous industrial peace. Either party may demand a settlement by arbitration in place of conflict. It is mandatory arbitration, the administration of justice extended to labor disputes. The system rests upon two broad facts. (1) That decision by reason is better than decision by force and (2), that there are three parties interested in every industrial trouble, labor, capital and the public, and as the public always wants arbitration if either of the other parties desires it also there is a majority of 2 to 1 in favor of peaceful settlement.

Local Boards of Conciliation were instituted with 4 to 6 members, half of them chosen by organized labor and half by organized capital, with appeal to a central court of arbitration of three members, one judge elected by the labor unions, another by unions of employers and the third (who is president of the court and must be a judge of the Supreme Court) appointed by the Governor who also fills all vacancies if workers or employers fail to elect. Whereever the workers in any trade are legally organized (any

five can form a union and register without cost) the law takes effect.

Any legal labor union (a union registered under The Trade Union Act or the Arbitration Act or both) and any employer or organization of employers may sue and be sued under the Act, but only organizations registered under the Arbitration Act can take part in electing the members of the conciliation boards and the judges, and either party to an industrial dispute may begin proceedings under the Act, after which anything in the nature of a lockout or strike becomes unlawful and the business must continue on the old terms until the case is settled. If a strike or lock-out has already begun before application for a hearing, it must stop and all discharged men must be reinstated. All concerned, employers, corporations and trade unions can be summoned ; the whole trade in the district can be brought into Court and the decision may be made binding on all employers and all workers, union or non-union, in the industrial district (or even throughout the Colony since 1900) and may be enforced by process against the person or property of a delinquent in the same manner as any other judgment of court. If the workers of any trade remained without legal organization they could still strike ; or if they disbanded their registered unions on due notice they could strike after existing proceedings and awards ceased to have effect or for a cause, not covered by the award ; or if organized labor and employers both determined to fight the matter to a finish and neither would call the other into court an old time lockout or strike would be possible. None of these things have occured ; strikes and lockouts have practically ceased to exist.

The workers of New Zealand know they can trust the Government and the judge it selects to be impartial and experience has shown the judgments to be so wise and fair that the Court has the confidence, not only of the workers and the public but of the great majority of the employers also.

The original Act included all the workers in factories and mines, builders, painters, carpenters, butchers, seamen, railway men, etc., but was held by the Court in 1899 not to include grocer clerks, street car men or livery stable employees. In 1900 however, an amending and consolidating act was passed extending the act to store men, clerks, farm laborers and all who work for wages or salaries except some employees of the National Government, most of whom are otherwise provided for. At the same time the Court was authorized to make awards for three years instead of two as under the original law, and it was further enacted that even after its term had expired an award should continue in force until one of the parties thereto applied to the Court for a revision. This means that only by the legal dissolution of all the registered unions of a trade, or the express fiat of the Court itself can a trade once regulated cease to be regulated. The Court was empowered to make awards binding throughout the Colony instead of making a series of district awards as before; to hold non-unionists to obedience to awards in their trade, and to hold new comers or persons entering the trade after the award bound by it without citing them into court for a hearing. The conclusions of the conciliation boards were made binding unless appeals were taken to the court instead of being as formerly mere recommendations for the enforcement of which the successful party must appeal to the court. Another amendment in 1901 permits either party to take the case straight to the court instead of going to the local board first. All the points of the law cannot here be stated, but mention must not be omitted of the referendum amendment of 1898, requiring that before a union initiates arbitration proceedings it shall be ascertained by ballot that a majority of its members wish to do so.

Smelting Ores By Electricity

Read before the Hamilton Scientific Association.
April 23rd, 1908.

BY C. H. DARRALL
Engineer of Tests, Westinghouse Co., Hamilton

The electro-smelting of ores and the making of steel in the Electric Furnace is a process which has been receiving a great deal of attention in the last few years. Numerous experiments have been made in Europe, and later in America, to determine if the process could be made a commercial success, and while it is regarded as a failure, by some, on account of its not yet being able to fill all the expected requirements, it has its advocates who pronounce it, for a certain class of work, under certain conditions, a decided success—one already worthy the attention of the commercial man who is looking for a good investment.

Up to recently it seemed to be the prevailing opinion, that so far as the reduction of metals from their ores is concerned, the electric furnace is not able to compete with the modern blast furnace. Nor is it suitable for the manufacture of steel for structural purposes or steel rails on a large scale ; but for special, high-grade steels it has already proved its usefulness and established a strong claim to a position in the industrial world.

The Electric Furnace was invented primarily with the discovery that an electric current passing through a medium produced heat, but more particularly on the discovery of the electric arc by Sir Humphrey Davy, who succeeded in producing an arc temperature of 6000° F.

When we consider that a very high temperature is absolutely necessary for smelting ores, but that it was very difficult to obtain and regulate, it is no wonder that

scientists have investigated so closely the adaption of the electric arc for smelting. The blast furnace, after a hundred years' trial and improvement, is probably now as nearly perfect or highly efficient as it ever will be ; but it has its limitations and its faults. Every ton of pig-iron produced by the blast furnace requires nearly a ton of coke; two-thirds of this is saved by the electric furnace.

In sections of the country where coke is expensive, and where water-power for electric development is plentiful, it would appear that there is already a very good reason for the electric furnace. Especially does this seem so in Canada (in Ontario and Quebec), where water-power is abundant, and where suitable coke can be cheaply produced from the refuse wood-cuttings from mills in our extensive lumber districts. The control of temperature in the electric furnace is ideal as compared with that of the blast furnace, and moreover the heating is not necessarily directly associated with the products of combustion.

There are many types of electric furnace, but they may be roughly classified as the type requiring electrodes and those not requiring electrodes, the latter being of the induction type. The most important of these are the "Keller" and "Heroult" furnaces for the production of pig-iron and steel, and the "Kjellin" and "Gin" for the production of high-grade steel.

In 1904 the Canadian Government appointed a Commission to proceed to Europe to examine the above furnaces and their operations, and a complete description may be found in the Report published by the Government.

The Keller Furnace, for the reduction of iron ores, resembles, somewhat, an ordinary blast furnace in appearance. It is of the resistance type, in which the resistance of the charge to the electric current produces heat in the charge. It consists of two iron casings of square cross-section, forming two vertical shafts which are lined with dolomite or other refractory material. The

shafts communicate with each other at their bases by a lateral canal, also lined with a refractory material, which forms a basin or reservoir for the molten metal while accumulating. The metal can be tapped off from this reservoir after the slag has been withdrawn from tap-holes, one at the base of each shaft, at a higher level than the tap-hole of the reservoir. The base of each shaft is provided with a carbon block and these blocks are connected outside the furnace by a copper conductor, so that the electric circuit is not broken when the molten metal is being tapped out. The two electrodes are supported one in each shaft, and are connected, one to each side of the supply circuit. They extend vertically downward about two-thirds of their length into the shafts. The charge, crushed to pass through a two-inch ring, is fed in around each electrode from the tap, and as it melts and descends it may be renewed continuously. In starting, the charge is introduced between the carbon-base block and the electrode on each side. The current passes from the electrode to the charge, to the carbon block, through the external copper conductor to the other carbon block, to the charge in the second shaft and to the second electrode. The resistance offered to the current produces heat in the charge which begins to melt, runs down into the reservoir and soon conducts the current internally to the second electrode. This continues until only a very small percentage of the current passes through the external copper shunt.

The electrodes are gradually raised to their normal position, and the charge is renewed until the space between the carbon blocks and the electrodes, and between the electrodes and the sides of the shafts are completely occupied by the charge. The ingenious application of the external copper shunt permits the continuous operation of the furnace without excessive variation of the load upon the alternator. The electrodes are approximately 3.3″

square x 55″ long. The consumption of the electrodes is usually slight on account of the low current density. The cost of electrodes per ton of product in this furnace is approximately .77 cents. It is believed that charcoal or peat-coke could be successfully used in this furnace as the reducing agent.

The electrical conditions in this furnace when smelting under normal conditions are approximately as follows :—

Mean voltage 70 volts.
Mean current 9900 amperes.
Power factor about 74%.
Mean K.P. 513.

The low power factor is accounted for by the iron casing which forms a continuous magnetic circuit around each shaft of the furnace, and which is highly magnetized by the heavy current, giving to the circuit a very high resistance.

In this type of furnace the energy absorbed per ton of pig was found to be .475 E.H.P. years for the run with furnace of 1,000 H.P. capacity with mean current of 11,000 amperes at 60 volts, and .226 E. H. P. years for the run with furnace of 308 H.P. capacity with mean current of 7,000 amperes at 55 volts—giving an average of .350 E. H.P. years. The cost of producing one ton of pig by the Keller process is estimated at $12.05, assuming electrical energy at $10 per H.P. year and coke $7 per ton. This cost might have been reduced if some means were devised to utilize the Carbon-Monoxide C.O. which was wasted.

The Heroult process for steel making permits the purification of material used, and different grades of steel can be made without difficulty.

The furnace for this process is of the tilting pattern. It consists of an iron casing lined with dolomite brick, and having magnesite brick around the openings. The hearth is formed of crushed dolomite, carefully rammed on top of the dolomite lining of the bottom of the iron casing. Two

electrodes pass vertically downward through the roof of the furnace. These are sometimes water-jacketed above and below their passage through the iron casing. The electrodes can be raised or lowered by hand or by an automatic regulator. In this way the intensity of the current can be closely regulated as the air-gap is increased or decreased. The current passes through one electrode, through the narrow air-gap, into and through the slag to the molten metal; thence along the metal to the slag and air-gap to the other electrode. The energy contained in this furnace in an ordinary operation is about 4,000 amperes at 110 volts A.C. The electrodes used are square prisms 14.5 inches to a side by about 68 inches long. The estimated cost of converting scrap into steel by this process, exclusive of the cost of the scrap and metal, is about $14.50 per ton of product.

Steel of a very superior quality can be made by smelting together charcoal, pig and scrap in the Kjellin Induction Furnace. As the name of the furnace implies, it operates on the principle of magnetic induction—no electrodes being required. Unlike the Heroult process of steel making, this does not permit the purification of the materials which go to make the steel, and the quality of the steel depends altogether upon the purity of the component materials. In this respect it is like the crucible steel process, but differs from it in that no gasses are present to impair the quality of the steel. Since there are no electrodes, there are no impurities from this source.

The Kjellin furnace is simply a step-down transformer, the primary of which consists of an insulated wire wound around one leg of a laminated iron magnetic circuit. The secondary consists of a single, continuous circular trough (which contains the charge) outside of and separated from the primary, but concentric with it. This annular groove is lined with magnesite or silicia brick, according as a basic or acid lining is required for the groove which forms the

crucible. The primary coil is insulated with mica and is kept cool by a jacket through which cold water is always circulating. The primary is connected to the supply-circuit delivering 90 amperes at 3,000 volts. It can be designed for voltages up to 5,000 or 6,000 volts. A current is induced in the charge which forms a single turn. Its intensity is 30,000 amperes at 7 volts, and the C2R loss produces the heat for smelting. The steel is tapped off from the spout of the groove, but a certain proportion is always left to maintain the secondary current. The temperature of the steel when tapped is between 1,600 C. and 1,700 C. The estimated cost of the production of a ton of steel by the Kjellin process is $34.

The advantages of this furnace are: 1. It permits of the use of high voltage direct on the primary winding. 2. There are no cables, connections or electrodes in the secondary.

The disadvantages are: 1. Very low power factor, due to the wide separation of the secondary and primary, and the low resistance of the secondary.

In the Gin furnace, which is of the electrode type, the trough in which the metal is held is doubled on itself several times, so that there is formed a sort of huge incandescent lamp, the gleaming molten metal forming the filament. The Gin process cannot be successfully used for the extraction of iron from its ores; but where electrical energy can be produced at a low price, it can be successfully used for the production of higher grade steel from pig iron.

The Stassano process employs a furnace of the arc type. In this process of the manufacture of steel or iron by electricity, the charge is calculated beforehand, and in the form of briquettes, is subjected to the radiation of heat from an electric arc situated above the charge to be treated. Nothing is added, so the calculations and output agree. It is simply a matter of compounding the charge according as it is desired to produce steel and iron. The furnace is

rotated while in operation to produce proper intermixture of the melting mass, and in this way the heat is used to better advantage. It is also claimed that the lining lasts longer as a result of the movement. The furnace is of the arc type, consisting of a cylindrical outer casing of iron mounted on a conical roof. The axis of the furnace while rotating makes an angle of 70° with the vertical. Three electrodes project inward toward the centre of the furnace, and they are connected to a three-phase supply circuit from which they draw 400 amperes at about 90 volts per phase. The distance between the electrodes is controlled by a hydraulic regulator.

This type of furnace has been used up to 1,000 H.P. capacity with an output of four to five tons per day. Four electrodes were used and supplied from a two-phase alternator, each arc consuming 2,450 amperes at 150 volts. The electrodes are round, two inches in diameter, by four to five inches long. The lining lasts under ordinary circumstances, and some trifling repairs, for about 40 days.

A report of the results of tests made by the Canadian Commission upon various processes in operation in Europe is given below :

Process.	Product.	Mean H.P.	H.P. Year Per Ton of Product.	Power Factor.	Frequency.
Heroult,	Pig Iron,	248	.47	75	80
"	Soft Steel,	480	.153		33
"	Tool Steel,	462	.153		33
"	Structural Steel,	465	.10		33
Keller,	Pig Iron,	834	.475	73.7	50
"	Pig Iron,	308	.229	56.4	37
"	Steel,	240	.112	85	40
Kjellin,	Steel,	195	.116	67.2	15
"	Steel,	203	.145	64.9	15

Coke used in crucible melting in Sheffield probably varies from two to three and a half tons per ton of steel produced, and even in the large gas-fired furnaces of

Germany and the United States probably one ton of slack, costing not less than $2.50, is necessary.

According to Harbord, cast iron produced in the blast-furnace varies in price from $10 to $12 per ton. With coke at $7 per ton, and electrical energy at $10 per H.P. year, the cost of production of pig iron per ton, by the electrical furnace, is about $10.71.

The following items of interest may be found in the Canadian Commissioner's report:

1. Steel, equal in all respects to the best Sheffield crucible steel, can be produced, either in the Kjellin, Herout or Keller process, at a cost considerably less than the cost of producing a high-class crucible steel.

2. At present structural steel, to compete with Siemens or Bessemer steel, cannot be economically produced in the electric furnace, and such furnaces can be used commercially for the production of only very high-class steel for special purposes.

3. The reactions in the electric furnaces as regards the reduction and combination of iron with silicas, sulphur, phosphorus and manganese, are similar to those taking place in the blast furnace. By altering the burden and regulating the temperature, by varying the electric current, any grade of iron, grey or white, can be obtained, and the change from one grade to another is effected more rapidly than in the blast-furnace.

4. Grey pig iron, suitable in all respects for acid steel manufacture, either by Bessemer or Siemen's processes, can be produced in the electric furnace.

5. Grey pig, suitable for foundry purposes, can be produced.

6. Pig iron can be produced on a commercial scale at a price to compete with the blast-furnace only when electric energy is very cheap and fuel very dear. On the basis of electric energy at $10 per E.H.P. year, and coke at $7 per ton, the cost of production is approximately the same as the cost of producing pig iron in a modern blast-furnace.

7. Under ordinary conditions, where blast-furnaces are an established industry, electric smelting cannot compete; but in special cases, where ample water-power is available and blast-furnace coke is readily obtainable, electric smelting may be commercially successful.

The Heroult process for the production of pig iron requires a very simple furnace, which is described more fully in a later part of this paper. The electrode is connected to one side of the circuit and the carbon bottom to the other side of the circuit. The energy is absorbed by the resistance of the charge, which is thereby heated to the temperature required for reduction. The furnace is operated on alternating current, and regulation is effected by adjusting the electrode vertically as in the Keller furnace, and it is possible to control the temperature of reduction within narrow limits.

This type of furnace was used, early the present year, at Sault Ste. Marie, Ontario, when Dr. Haanel, Superintendent of Mines, and Dr. P. Heroult, the inventor of the furnace, made a series of experiments to determine the following points:

1. The amount of electric energy required per ton of pig iron.

2. Whether magnetite, our chief Canadian ore, could be successfully and economically smelted by the electric process.

3. Whether iron ores, with comparatively high sulphur content, but not containing manganese, could be made into pig iron of marketable composition.

4. Whether charcoal or peat coke, which can be cheaply made from mill refuse, and other sources of wood supply, useless for other purposes, could be used instead of coke as the reducing agent in the electric furnace.

The furnace for the Soo experiments was designed by Dr. Heroult, who also conducted the experiments. It consisted of a cylindrical iron casing mounted vertically and

bolted to a bottom plate of cast iron 48 inches in diameter. The casing was made in two cylindrical sections to facilitate repairs. To render the inductance as small as possible, the lines of magnetic force in the iron case were prevented from closing by the replacement of a vertical strip of 10 inch width of the casing by a copper plate. Carbon paste was rammed in the bottom of the furnace up to the lower part of the crucible. The lining consisted of common firebrick, which from the bottom of the crucible up for a distance a little above the slag level, was covered with carbon paste to a thickness of a few inches. The lining of the furnace was made the shape of two cones, set base to base, having dimensions as follows :

Dimensions	at bottom of crucible,	24 inches.
"	at widest part, - -	32 "
"	at top of furnace, - -	30 "
Length, - - - - - - - - - -		44 "

The electrode was a square prism 16 in. x 16 in. by 6 feet long, The contact with the cables carrying the electric current to the electrode consisted of a steel shoe riveted to four copper plates, which ended in a support for a pulley. The electrode, with its contact, was supported by a chain passing under the pulley, one end of the chain being fastened to the wall, the other end passing over a winch operated by a worm and wormwheel. This formed a convenient arrangement for regulating the electrode by hand. The energy was furnished by one phase of a three-phase 400 K.W. 30-cycle 2,400 volt A.C. generator belted to a 300 H.P. 50c volt D. C. motor. A current at 2,200 volts was delivered to the primary of an O.I.S.C. transformer of 225 K.W., and stepped down to 50 volts. This transformer was placed in a room adjoining the furnace room. The current of approximately 5,000 amperes at 50 volts was delivered to the furnace. The instruments used were a voltmeter, armeter, power factor meter, and record-

ing wattmeter. The transformer and instruments were manufactured by the W. E. & M. Company.

The materials of the charge, ore, flux and carbon were crushed to pass through a ¾-inch ring, and roughly mixed; 150 casts were made, producing 56 tons of pig. The average conditions of ore run for the production of grey iron was as follows:

Length of run, - - - - - - - - -	12 hours.
Mean volts, - - - - - - - - - -	38.5 volts.
Mean current, - - - - - - -	4,856 amperes.
Power factor, - - - - - - - -	91 9-10%.
Pig produced, - - - - - - - - -	2,665 lbs.
Watts consumed, 38.5 x 4,836 x .919 =	171,812.
E. H.P. consumed, - - - - - - - -	230.3.
Output of pig per 1,000 E.H.P. days,	11.57 tons.
E.H.P. years of 365 days per ton of pig,	.236.

It was expected that considerable difficulty would be experienced in the smelting of magnetite on account of its conductivity. It was thought that, with the furnace in use, in ? electrode was immersed in the charge, the current would disseminate itself laterally from the sides of the electrode through the charge, preventing the current at the reducing and fusion zone from attaining such density as would be required for the high temperature necessary for reduction and fusion.

With charcoal as a reducing agent, no difficulty was experienced, nor was the inductance of the furnace increased by the presence of the magnetite. The consumption of electrode per ton of pig was 17.98 lbs. The power factor, 91 9-10%, was very high, and this was due to the construction of the furnace casing, which prevented the closing of the magnetic lines of force.

The experiments indicated, that under normal conditions, about 11.5 tons of pig were produced by an expenditure of 1,000 E.H.P. days.

A summary of the results of the Soo experiments follows :

1. Magnetite can be as economically smelted by the electro-thermic process as hematite.

2. Ores of high sulphur content, not containing manganese, can be made into pig iron containing only a few thousandths of a per cent. of sulphur.

3. The silicon content can be varied as required for the class of pig to be produced.

4. Charcoal, which can be cheaply produced from mill refuse, etc., can be substituted for coke as a reducing agent without being briquetted with the ore.

4. A feroo-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickeliferous pyrrhotite.

6. Titaniferous iron ores up to about 5% titanic acid can be successfully treated by the electric process.

When we consider that the modern blast-furnace and the different methods of steel making are the result of a hundred years' experience, and that the electric furnace has been invented in very recent years, and is, therefore, yet in the experimental stages of development, may we not assume that some future improvements will make it a keen rival of the older methods ?

The following are significant facts :

The electric furnace is applicable to the smelting of such ores as copper. It is very simple in construction. The available temperature is 1,000 C. above that of the blast-furnace, and the regulation of the heat supply is under perfect control. Familiarity with handling heavy currents and experience already gained in smelting, will aid materially in solving the difficulties encountered in the smelting of ores, which up to the present time, have proven refractory to all known processes.

The electric-thermic principle is made use of in removing the obstructions which form and cling to the inside of a

blast-furnace, impairing its operation and endangering the lives of the attendants, and the furnace as well.

This "scaffold," as it is called, is formed of metal, which on account of some cause, such as failure of the draft through the tuyers, becomes chilled and adheres to the sides of the furnace. This "scaffold" forms a projection from the side of the furnace above the reducing zone, where it is very difficult to be reached by heat, and where it cannot be removed by the ordinary operation of the furnace.

On the contrary, when once started, the "scaffold" tends to increase by the adhesion of other molten matter becoming chilled on its surface. If this continues, the "scaffold" becomes a support to the whole charge above, with the result that it finally gives way, allowing the mass of the charge above to drop through the base of the furnace and probably killing the attendants. This accident is very dangerous, comparatively frequent, and costly, especially to water-jacketed apparatus.

The means which have been most successfully employed to prevent the above danger, is that of using the electric arc to fuse the chilled adhesions which can be reached without interfering with the regular operation of the furnace. For this service either D.C. or A.C. can be used at a potential at from 75-50 volts and 500-1,000 amperes.

With A.C., the proper voltage can be readily obtained by a transformer situated near the blast-furnace. With D.C., from a standard 125-volt supply by means of a water rheostat in the circuit. One side of the circuit is clamped to the outer casing of the blast-furnace and the other to a long carbon 1½ inches in diameter, made for the purpose by the National Carbon Co., or the International Acheson Graphite Co. This electrode is supported in any convenient way for handling, for example, by a long pipe, etc.,

and is then applied to the chilled mass which it is desired to remove, the electric arc fusing the metal.

Mr. Price, Chief Electrician of the Algoma Steel Works, has been performing this operation by D.C.

Best results were obtained by connecting the furnace casing to the positive side of the supply circuit. The current was easily regulated by a water rheostat, and remained very steady at about 600 amperes.

The Algoma Steel Company have recently purchased from us a 75 K W., O.I.S.C., transformer, which they will in future use for the above purpose.

Other processes closely allied to those dealt with in this paper are those which deal with the production of calcium, carbide, carborundum, graphite, alundum, copper, arsenic, molybodenum, tungsten, nickel, sodium, aluminum, phosphorus, glass, calcium, strontium, corrundum or artificial emery, and zinc.

In the electric furnace, ores can be treated which could not be economically treated in the past.

Ores of high sulphur content can be made into pig iron containing only a few thousandths of a per cent. of sulphur.

Titaniferous iron ores, containing up to 5 per cent., can be successfully treated. The silicon content can be varied as required for the class of pig to be produced.

As reducing agent, it is not necessory to use coke in the electric furnace, since charcoal and peat coke can be satisfactorily employed.

An excellent summary of the present situation in the application of the electric furnace for steel making and iron reduction is given in two reports by Eugene Haanel, and is published by the Canadian Government.

The first report of the Commission is on the different processes employed in smelting iron ores and the making of steel in operation in Europe, and the second report was issued on the experiments made at Sault Ste. Marie, Ont.,

under Government auspices in the smelting of Canadian iron ores.

Steel refining in the electric furnace is considerably cheaper than the crucible process. The cost depends largely on the degree to which the impurities are to be eliminated, and is relatively small if steel to be refined is supplied to electric furnace in molten state from the open hearth or Bessemer converter.

Especially in two departments of iron and steel industries has the electric furnace been commercially successful and applied for various purposes. The production of ferro alloys, such as ferro-silicon, ferro-chromium, etc., it is specially adapted to the required work through the high temperature available.

While in the manufacture of special steels, its value lies in the ease of control and the possibility of preventing impurities in the finished product and the various alloys, especially those of high percentage and low in carbon are quite successfully produced.

The usual reducing agent is carbon. But silicon or ferro-silicon or carborundum is also used for the production of other ferro-alloys free from carbon.

BRIEF REVIEW.

Electro-chemistry embraces so many and varied industries to-day, that we meet almost daily new processes in successful operation, so rapid is the progress in this branch of the science, and present systems are being continually improved and rendered more efficient. But fifteen years ago many of its products were unknown, as carborundum.

A brief summary of the most important commercial products of the electric processes can be given in a paper on the subject.

Of these industries, that of greatest importance is copper refining. The electrolitic copper produced during 1903 is estimated at 318,000 tons, of which the United

States produced 86%. It is also known that the value of American electrolytic refineries has doubled in the last six years, although the exact figures are not available.

The second in importance, no doubt, is the production of aluminum. This has been a staple article for a number of years.

Another extensive use of the electric furnace is in the manufacture of calcium carbide. This, through contact with water, gives off acytelene gas, and the rapid development of acytelene gas lighting is largely due to the growth of the calcium carbide industry.

The carbide is produced by heating together in the electric furnace a mixture of 65% lime with 35% carbon or coke. This is being carried on in a large scale at the Shawinigan Falls Carbide Co., near Montreal.

The to-day widely used abrasive carborundum was discovered by E. J. Acheson, of the Acheson Graphite Co., Niagara Falls, Ont., while conducting some experiments in the production of aluminum, which he developed through later highly successful experiments. It had been noticed that in the case of overheating of the carborundum furnaces, that some of the crystals next to the heating core, and which were subjected to the highest temperatures, were entirely converted into graphite. This suggested the method, which as now followed, results in the production of pure graphite, having only a fraction of one per cent. of ash.

GEOLOGICAL SECTION.

Report of the Section for the Year Ending May, 1908.

To the President, Officers and Members of the Hamilton Scientific Association :—

GENTLEMEN,—The members of the Geological Section of the Hamilton Scientific Association, in presenting this report for the year ending May 14th, 1908, desire to express their pleasure at being able to state that substantial progress has been made in the year just closed by the section in the study of geology and in the collection of fossil specimens peculiar to the different rock formations in this vicinity. An interesting discovery was made by Mr. Horace Sayman of mineral tar, which he obtained from an abandoned quarry, known as Carpenter's quarry, on the Barton and Glandford road, west of Dundas. Through the indefatigible exertions of Col. C. C. Grant, quite a large number of fossil remains have been collected, some of which have been placed in the museum of the association, among which are some very fine specimens of Graptolite obtained from the city quarries, which no doubt will prove to be when examined, new varieties, and very probably, new species. Col. Grant has received fifteen letters from the Curator of the British Museum of Natural History, London, acknowledging the receipt of more than 204 fossil specimens from the rocks at Hamilton and shingle on the lake shore at Winona and the Hamilton Beach. Letters have also been received from the officers of the Canadian Geological Survey, acknowledging the receipt of fossil specimens for the Ottawa museum, and express-

ing the hope that they would be able to make quite a good display of the fossils sent down to them from time to time by Col. Grant when they complete the rearrangement of fossils in their new cases, which are being built. The collection of fossils from the Cambro Silurian shingle along the shore of Lake Ontario, near Winona, was attended with some difficulty, owing to the high water which prevailed, being more than two feet higher this spring than in former years, and the prevailing east winds with the larger body of water has been making encroachment upon the shore land, washing away large quantities of earth, thereby reducing the acreage of those whose farms reached the shore line.

There must be some local cause for the high water on the southern shore of Lake Ontario, because there appears to be a difference, relatively speaking, between Ontario and the Upper Lakes as to the height of water above the ordinary lake levels at this season of the year.

The museum has been free of access to any one who desired to visit it for the purpose of study, and quite a number have availed themselves of the opportunity. The section hopes to have a better arrangement of the fossils in the cases. With a more correct stratigraphical grouping it will be easier to trace those genera, species, or varieties which have survived the period in which they were first discovered and have passed up into more recent deposits, and it will aid the student of biology in his researches in palaeozoic life.

The section learns with deep regret that the local government has seen fit, without any apparent reason or complaint known to the section, to cut fifty per cent. off the yearly grant to one of the oldest, if not the oldest scientific institution of its kind in Canada, and one which has done excellent service in the interest of scientific investigation for many years, and which through the liberality of its members has maintained an active existence. This action on

the part of the government seems to be a slap at all and sundry such institutions situated outside of Toronto.

The section has held several meetings, at three of which papers of geological interest were read. Following are the dates on which papers were read and by whom :

Nov. 29, 1907.—Notes on the Late Collecting Season, by Col. C. C. Grant.

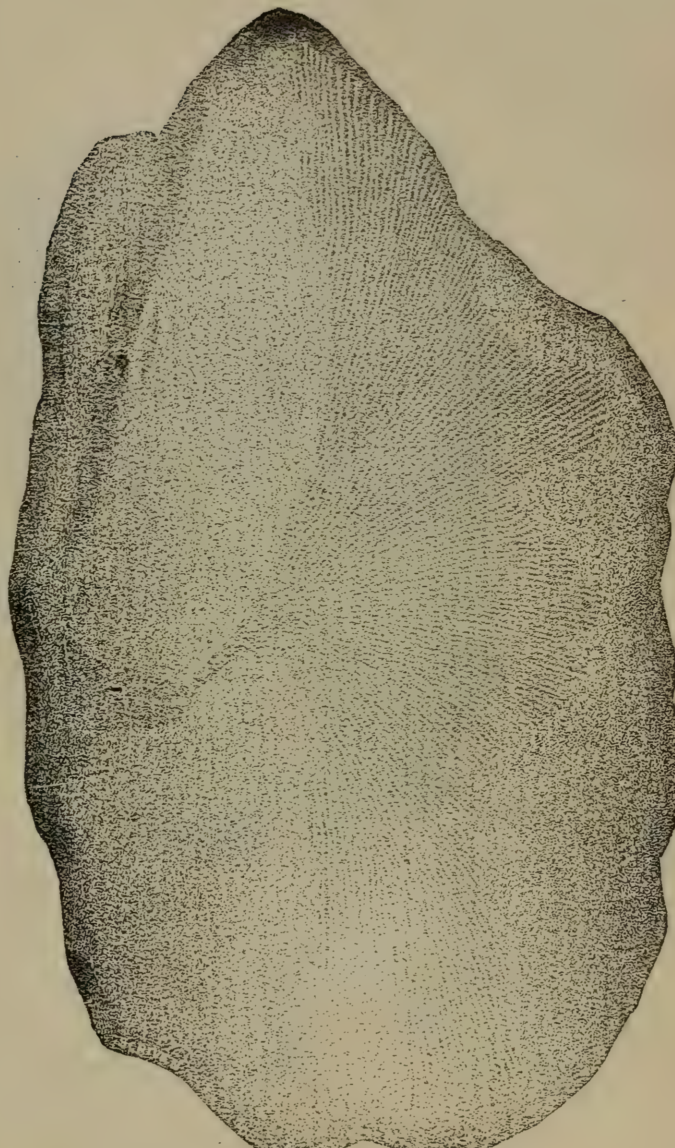
Dec. 27, 1907.—Notes on the Late Collecting Season, Continued, by Col. B. C. Grant.

March 27, 1908.—Notes Geological and Antiquarian, by Col. C. C. Grant.

A. T. NEILL,
President of Section.

No. 1—Two-thirds actual size.

No. 1.—This fine Graptolite was found in the new City Quarry by Mr. Nichol. In the absence of Cellules still undiscovered I do not feel inclined to represent it as an Inocaulis, I am inclined to think it may belong to a new Genera. Two or three of the same shape with slighter branches however were noticed in Niagara Shale and led me to the conclusion that they were members of the family group. One specimen occurs on a massive building bed.

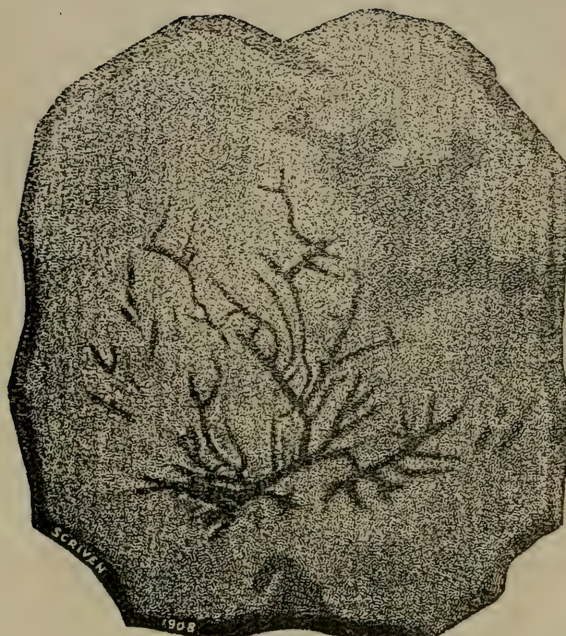


No. 2

No. 2.—Acanthograptus (Spencer) Is perhaps a new species or variety.

No. 3

No. 3.—Acanthograptus also differ from the former, both are in the upper glaciated chert and are not common. All fossils figured in our proceedings are, we may add, supposed to be unknown to science here.



No. 4

No. 4.—Only two specimens were seen in a quarry at the head of "The Jolley Cut" possessing the stalk of a Callograptus. The first obtained led me to suppose it to be a connecting link with Dictyonema as bars put in an appearance rarely at intervals. Perhaps that may be owing to bitumenous matter spreading from one branch to the next.

Notes On The Late Collecting Season.

Read before the Hamilton Scientific Association, November 29th, 1907.

BY COL C. C. GRANT.

The writer accidentally learned that another quarry had been opened near the head of the Jolley Cut in March, long before the snow disappeared. On arrival at the City quarry, on seeing the appearance of things there, he erroneously concluded he must have been misinformed, and thought it unnecessary to proceed beyond that. A visit was paid later on, when its correctness was fully established. Its position is next to the old Hancock quarry, which ceased work for several years, but which was reopened last season in order to obtain some material for building purposes from a small strip of limestone still remaining. It was from this place, late in the fall, that I obtained the remarkably fine Graptolite which I brought to the notice of the Geological Section—a circular form, resembling Dictyonema retiformis, but without the connecting bars.

I noticed the glacial clay seemingly occurs merely in patches in this new quarry, but only a few yards of overlying soil was removed from the front up to the date, 6th April.

On quitting the quarry to-day, I concluded to have a look at the low-lying fields close to the Corporation drain in order to ascertain whether they were sufficiently dry for examination. I found, however, they were not, except in the higher portion, but I managed to pick up a fair specimen of Roemers Tennessee sponge (Astylospongia inciso-lobata), and a very singular Bryozoon, the only one of the

kind I have seen. In shape it resembles the tail shield of an Acidaspis, but the parts corresponding to the spinal process of the trilobite are covered with cell pores.

Nothing was found in the chert layers removed last autumn in deepening the Corporation drain. Their examination was very superficial, yet I fear the non-fossiliferous beds alone were then disturbed. It was also seen that in the adjacent fields little material was brought to the surface by the late winter frosts. This was owing to the non-disappearance of the snow covering during the entire season, a circumstance not common in recent years.

On the whole I fear the prospect of a successful collecting season at this early stage is by no means a very bright one. There are no fresh fields remaining for investigation overlying the Niagara chert between Hamilton and the Little Horseshoe Falls near Albion Mills (base of the Barton Niagaras), and few sponges or sections seemingly are now obtainable in places where they were formerly found in considerable numbers. Foreseeing their gradual disappearance the writer secured many sections, beside the ones in the City Museum. Near the mouth of the Corporation drain, close to the road on the brow of the escarpment, a clover field if ploughed up since I visited it late last autumn may make matters a little brighter. It afforded me many specimens formerly. Here I feel it necessary to state I never considered the sponges or sections along there were deposited in the same way as others nearer the city. The beds there were unprotected by glacial clay. The thin soil and weathering process rotted away the soft layers in which they were embedded. The plow and frost brought the harder chert to the surface. Few if any fossils have been brought to the surface by frost during the past winter. This the writer ascertained by collecting small heaps of chert flakes to mark certain places where specimens were found, and burying one or two others near them, in swampy places chiefly. The latter he found undisturbed,

the snow lying on the ground during the entire season prevented the frost from penetrating there. The grass fields were found in a similar condition to what they presented in the autumn, and furnished a fine specimen of a tabulated coral, similar to the one figured in last year's Proceedings by our treasurer, Mr. Scriven. A fair number of Brachiopods and Bryozoons were also obtained, and several varieties of Hall's Cladopora. Although this family group (exceedingly numerous in our chert beds) is represented as a coral by Rominger and other well-known Palæontologists, perhaps a close investigation may yet prove that Prof. Foorde, formerly of the Canadian Geological Survey, was not far astray when he claimed it as coming under the head of Monticulipora.

The fields on the brow of the escarpment, between the reservoir and the rock cutting were not visited until the middle of May, the writer feeling too weak for a long walk before that. A portion of the field beyond the orchard, which proved so rich formerly in sponges and sponge sections, had been freshly ploughed up before his arrival. The soil overlying the chert is quite thin there, and the weathering process evidently has laid bare organisms peculiar to layers not represented nearer the city. No complete sponge was discovered, and only two sections, which leads me to think the field is now deficient in this material. Recollecting a swampy part formerly produced some fine specimens of Dr. James Hall's Lichenalia, I confined investigation to the part in question, and despite the difficulty of distinguishing the white Bryozoon on the weathered, colorless cherts, I contrived to pick up on the surface no less than seven fine samples in about an hour or a little more.

The present City quarry at the head of the Strongman road, which produced so few fossils when compared with the ones worked at the head of the Jolley Cut, appears to be making up for its deficiencies by producing some well-preserved remarkable specimens lately. Just before I pro-

ceeded to Winona and Grimsby on an annual collecting tour, my friend, Mr. Nichol, the superintendent, called my attention to one of the finest specimens of Graptolites he had ever seen. On its production I found he was not far astray when he stated it might be new to both of us. It certainly is a magnificent one but difficult to classify, and may belong to a new genera. Perhaps some may look on it as an intermediate form between Inocaulis and Acanthograptus. It comes from the inside of a thick limestone layer, the second or third, I think, of the blue building beds below the chert. We may leave this question to some Palæontologist who is particularly interested in the Hydrozoa family for final determination. Presumably this would prove satisfactory to all of us.

I remember setting aside, a few years ago, some specimens which the crowded state of the museum cases prevented me from placing in them until additional space was provided. Among others that struck me, as far as I could remember, was one Graptolite discovered in the shales of a Jolley Cut quarry which bore a resemblance to Mr. Nichol's remarkable fossil. After a long search, it turned up. It was looked upon at the time by myself and others probably as a new species of a narrow branched Inocaulis. On comparing this one with the other, while they belong to the same family, they may differ as regards species; the branches in my specimen are further apart and more slender. It is far inferior in preservation, for a portion is deficient.

Mr. Nichol's splendid Graptolite unfortunately appears on such a heavy limestone layer, that I fear for the present it must remain in the same condition as when obtained. An attempt to make it more portable may result in its injury.

WINONA AND GRIMSBY.

The first thing I noticed at the former place on arrival there for the summer collecting tour, while standing on the high bank above the lake, was that the water appeared to be very low for the time of my arrival; that a large tree had been washed ashore and embedded in the sand; that another one in front of A. Wilson's had toppled over and was partly submerged in the lake since last summer, while a third one, lying a little to the west then, had disappeared altogether. On proceeding down the slip adjacent, I ascertained a considerable amount of sand had collected about the two former, and the latter had not actually disappeared as I imagined, but was merely hidden by the accumulated material which had gathered there. This was removed by the water of the lake in rough weather a few days subsequently, and it was found a little to the west of the Park that the lake level appeared higher, if anything, than in former times.

Only when the water was perfectly calm could I obtain a few specimens (dry shod) from the low glacial clay cliffs near the ravine to the west of the camp. The majority were regular not polished or striated. Only in a few cases they held common Hudson River fossils, and the embedded shingle appeared to be far less numerous than in former years in the glacial clay cliffs.

The way in which the sand, gravel, etc., collects in places along the shore differs considerably, and is often calculated to mislead one regarding the lake level. Less than two miles to the east of the camp is a pond which four years ago was fed by a stream from the lake eight inches deep. Last year it disappeared altogether, giving the locality the appearance of a recession of water level at a short distance. Such is not the case, for not many yards to the west, even when the lake was perfectly calm, I noticed last June how rapidly the waters were encroaching

landward ; indeed the process appeared to me to be so rapid as to lead one to believe the low lying fields to the south adjacent may be submerged before many years, unless a shifting sand barrier is thrown up in front for their protection. People here are slow to believe that the land to the north is rising. The conclusions of the United States scientific men on the point admit of dispute.

On the receipt of a letter by the writer some years since from one who published several interesting communications regarding this slow elevation, Prof. Gilbert, the well-known United States geologist, considering that the Chicago canal lately opened, which conveys a portion of Lake Huron water through the Mississippi channel, might prove injurious to inland navigation, he was surprised to find the water of Lake Ontario was actually higher than for many years. It seems hard to account for the circumstance when we remember there was no unusual rainfall this year, or deep snow last winter. The farmers who own property near the lake, and are now fully satisfied that its water is rapidly encroaching on their land, have arrived at the conclusion that it is at least five inches higher this year in June than it has been for several years, since their attention was first called to the matter in question. The writer has been informed that in recent years the suggestions of England's field geologists regarding the rapid sea encroachment has led to some attempt to arrest the progress.

I certainly was disappointed in not finding a few more Ohio Orthodesmas on the lake shore last summer. There was little change in the shingles from the previous years, and my handi-work in the shape of broken material was noticed for a considerable distance from the camp.

The writer called the section's attention last session to some species of Feldspar (Orthoclase) found in the glacial drift at Winona. On proceeding last June to Grimsby from the camp by a byroad near the Hamilton & Beamsville railway line, he discovered a massive, erratic boulder close

to the place of this mineral. It is about three feet in height, but this could not represent the thickness of the bed originally, judging from its present appearance of pure Orthoclase. No other ingredient was noticed in it.

While I am almost certain fragments of Serpentine found during the late collecting season there came from glacial clay also, as lying loose close by, it cannot be actually claimed as derived from it perhaps.

While we were all satisfied regarding Dr. Spencer's views as to Burlington Heights representing the ancient Lake Iroquois beach, when old members of the Geological Section may remember considerable difference prevailed among ourselves, an early paper by one of our members, Wm. Kennedy, attracted much attention. He considered the Grand River, which found its way from the direction of Dundas, deposited at its mouth in the still waters of the great lake the material which composes that vast accumulation of water-worn limestone, shingles and sand which runs through the city and displays itself as a gigantic ridge at the Central School. Another expressed his opinion that the Beach represented a glacial Moraine. A gentleman from Chicago supposed the chief part of the material (Hudson River) was conveyed from the north shore bed of the lake, forced by winds and currents to the head of the lake. None of the foregoing theories satisfactorily account for the presence of Archæan rocks. If a deep channel exists in the middle of the lake resembling the Niagara gorge, as stated, how could the material washed into it find its way out? It seems impossible.

The writer thinks that the few places along the lake shore near Winona containing fossils merely represent a remnant of a glacial clay deposit extending continuously for miles. At the pond to the east of the camp at a comparatively recent time the waters of the lake burst through the barrier washing away the clay deposited, but leaving many of the larger rock specimens scattered on the strand similar to the

one imbedded which I extracted close by three years ago, and which furnished me with a well-preserved Ohio Lamelli branch (Orthodesma curvata). Visiting this particular place, I ascertained the bank nearly up to the fence had disappeared since examined last year. During a close study of the locality for several summers, I never noticed before such a rapid encroachment as the water of Ontario has made there on the land. Indeed, I felt inclined to think that the slow rise of the northern shore may have increased recently. While he never questioned the proved conclusions of the professional men, the writer never for a moment imagined that the few isolated patches still remaining of glacial clay could have produced more than a small portion perhaps of the sands, shingle, etc.

We all know this deposit underlies Burlington Heights, the ancient Lake Iroquois Beach, and no doubt the large volume of water which formerly rushed down by Albion Mills, Stoney Creek, Grimsby, etc., conveyed a considerable portion of the material which contributed to build that vast accumulation known to us as the Burlington Heights.

We may be unable to state positively how far the glacial clay extended into Lake Ontario, but one thing may be safely asserted, for thousands of years its waters have been battering away at the clay cliffs on its southern shore, combing out and spreading broadcast all the land ice brought from the north, and what a vast collection of igneous rocks, of granites, feldspars, green stones, accompanied it. Some years since the writer, while hunting for Indian relics at Lake Medad, noticed an erratic boulder there of Jaspar conglomerate, and on showing a fragment to a Canadian gentleman, he quietly remarked, "You will find that rock in situ to the north of Lake Huron, and I have seen it there." So it must have crossed the frozen lake if confined to this locality. Your collector considered it unnecessary to extract more than a few Archæan specimens from the glacial drift, since he has submitted already

several for inspection at a former meeting, obtained from the deposit. The glittering red Orthoclase so often noticed in beach shingle occurs also in the drift; but the Serpentine is, I think, the first observed at Winona. Probably it came from that also. Had it been where found detached last year it must have been seen, yet it was not above high water mark.

FOSSILS FROM DRIFT AND SHORE SHINGLE.

With regard to the numbers collected on the lake shore last season, you may not notice any considerable falling off, taking into consideration that only in a few places any fresh shingle was exposed along the beach ; yet it must be admitted that very few rare fossils were secured in anything like fair preservation. Without the original for comparison, the writer has often expressed his unwillingness to name organisms from published figures, too often inaccurately represented. I may not be far astray in considering one of the best now submitted for your inspection as identical with the late Prof. Billing's Lamellibranch Modiolopsis Gesneri from the Trenton series at Ottawa, Corresponding specimens were placed and named in the City Museum cases before our collection was broken up.

A Lingula was obtained under singular circumstances. In extracting the cast of the valve of a shell in the Cambro Silurian shingle it split across under the hammer, revealing the fossil and mould underneath, embedded in the muddy sediment which filled the interior of the dead bivalve. The latter I sent to Ottawa, remarking I could scarcely separate it from the Clinton Lingula oblata (Hall). The posterior margin was incomplete, and on re-examination under the lens it appeared to be nearly related to Lingula Kingstonensis (Billing's). If it can be established, we may add it to many other rare fossils of the glacial drift, which members of the Geological Section discovered at the lake shore, Winona.

While disappointed in not finding a few more of the Ohio specimens of last and preceding years, yet perhaps the late summer visit to the lake shore, considering the circumstances, may not be thought unsatisfactory. I found among the specimens brought in from Winona a fine slab containing several members of James Hall's Minute Brachiopod (Septobolus Occidentalis). The doctor records it as occurring in the Hudson River series. The writer supposes it may be found also in the Trenton still lower, but as other specimens were associated with fossils which are common to both, it must be admitted, the evidence on this point is very unsatisfactory.

Two valves of the Trenton Lamelli branch, separated (Modiolopsis Gesneri, Billing's), in good preservation, were obtained. It may be inferred that the one described was the only one known to the Palæontologist, it appears to be by no means rare in the shore shingle, or glacial clay, near Winona, but as a general rule it is difficult to extract it uninjured. The specimen now produced is much superior to any found previously.

An appropriate name for a Bellerophon extracted from beach shingle was given by Sowerby to a Devonian form in England many years ago. Probably it is known already here or in the States, but I have not seen it figured or described. There were two specimens on the slab, and after I had secured the one, a young fellow who was with me requested me to let him have the other if he succeeded in getting it out, as he wished to show it to some friends. We were all, he said, greatly interested in an astronomical lecture given by Dr. Marsh some time back, a member of the Hamilton Association. Under such circumstances, I could not well refuse. His was far superior to mine.

The glacial clay furnished a fine specimen of an Orthoceras, which may be an intermediate form between Orthoceras Simulata and Oregulare. I forget the name attached to the latter by American Palæontologists, but the

late Prof. E. Chapman, of Toronto University, informed me it was identical with one thus named in Europe. A second slab was obtained from it with several others imbedded, but only a fragment was extracted. A third slab revealed specimens of a Bryozoon, which represents perhaps a Cambro-Sil (Lichenalia). One I sent to the Dominion Survey Office at Ottawa, expressing this view.

GRIMSBY.

During my stay at Winona during the past summer, only one visit was paid to the above mentioned locality, although another was intended to ascertain the possibility of making a fine specimen of the large Arthrophycus Harlani, detached from the upper Clinton band since last year, sufficiently portable for conveyance to the railway station. No crinoids were obtained, but I returned to the camp with some interesting Niagara shale slabs, holding well-marked Bryozoons, plates of Caryocrinus Dictyonella, together with two good specimens of the small Arthrophycus, and another which may be an intermediate variety perhaps. I failed to extract a remarkably fine Platyceras, a shell which appears to be exceedingly rare in our local Niagara rocks, and which seems to be frequently found in the Niagaras in the States. A large Platyostoma, under the hammer, got lost among brushwood. I also failed to discover it, unfortunately.

Disappointed in securing any well-preserved sponges, or even sections, with few exceptions, after the snow had disappeared, I thought it would meet the wish of the Geological Section to devote a separate chapter to the fossils discovered later in autumn when the crops were gathered in. As far as he can see, your collector has no other reason for departing from his intention in former years, where the whole season's collection was submitted without any distinction. Perhaps at a future time members may feel inclined to join the section, who may be prevented from doing

so by their respective employments in the more busy spring months, and I believe it may be found, after all, judging from the writer's experience during the past few years, to be the better time for collecting upper chert specimens. In a recent visit to the Hesse Spring Farm for the purpose of obtaining a few Indian relics for the Dublin Museum, close to the limekiln, on the surface of the field, I was rather surprised to find a chert sponge section, as also a much decayed slab from the lower Silurians, containing an Ambonychea and Monticulipora, and close beside lay a fine specimen of an Indian fire stone. The fossils were conveyed there in the Glacial Age evidently, the sponge fragment occurring eighty feet perhaps above its natural site. Several Archæan weathered specimens were also noticed there.

AUTUMNAL COLLECTING SEASON.

Some years ago when the City quarry was worked during the winter, even when snow had to be removed to get at the chert beds, I placed before a visitor a large number of Graptolites I collected there a day or two previously. He evidently was surprised at the specimens obtained, and remarked, "Surely this cannot be the best time for collecting?" No, it certainly was not. A coat of ice on the surface of a layer frequently conceals the Graptolite underneath. On recalling the conversation lately, the writer thought it advisable to make a little distinction in the spring and autumnal searches for sponges, and flint-flake fossils in the fields near the brow of the escarpment and Corporation drain. I noticed last year more specimens had been acquired when the crops were removed than before they were planted.

In some of the well-known fields this year the nature of the crops seemed more favorable for collecting than usual, but I almost despaired of much success when recalling the difficulty of failing sight. I thought it likely that

I might possibly obtain a few Lichenalias and sponge sections, but concluded there was only a remote chance of getting any complete sponges unless accidentally. Yet I was agreeably surprised to find my anticipations proved quite incorrect. One of the fields near the Corporation drain furnished me, when the oats were removed, with two specimens, not, however, completely weathered out of the flinty masses in which they were enclosed ; another field more distant from the city, under a similar crop, furnished four or five others, and the further end of the field, where potatoes were planted, yielded up two others in good preservation, which seem to differ from any Tennessee specimens known to me. As these may possibly be unknown to science, I sent them away to the British Museum for closer examination. Subsequent to the discovery of the latter, I was persuaded to give "Specks," discarded some time ago, another trial. I was not satisfied they would be of much assistance in fossil hunting, but like a Canadian statesman, in a weak moment I yielded, and the result proved more satisfactory than was expected, for the first time I tried them on I managed to pick up two exceedingly minute Astylospongias, which never could have been found without them perhaps.

Dr. Parks, of Toronto University, having informed me he intended to study and publish a paper on the Stromatoporæ family, the writer remembered a field on the brow of the Niagara Escarpment, not far from the railway rock cutting, where he obtained several years ago specimens of a chert Stromatopora which he believed might have been unknown to the late A. E. Walker, or Sir W. Dawson. On proceeding to the place indicated, a good but not a perfect one was discovered in a portion of the field planted with tomatoes. This as well as a few others from the Clinton and Barton Niagaras, which turned up unexpectedly, I forwarded to the Professor. He received previously from Hamilton another member of the

group named by Dr. Spencer, F.G.S., Cannopora Walkeri, which was formerly noticed as occurring attached as a parasite to the upper surface of a Clinton Favosites Coral.

The writer was prevented from examining a portion of two fields where a late crop of Indian corn and potatoes had been removed, owing to an accidental injury to his foot. He found in one case the place where he fully expected to secure a few complete sponges, had been freshly ploughed up. In the other instance, quite a large quantity of the leaves of the crop removed had been left where it was, which rendered it impossible to detect fossils, except by chance on the surface. In other cases the farmers were as busy in turning up the soil as the writer in hunting up the specimens.

NOTES.

The writer learns that when some denounced the issue of the Text Book on Physical Geography by authority, in 1904, as an attempt on the part of Infidels or Agnostics to heathenize the children of the High schools of both sexes by teaching, through astronomy and modern geology, principles of open infidelity, the matter was brought to the notice of the Educational Board, apparently by the Anglican Synod of Ontario, but it saw no reason for suppressing and recalling the publication.

Since calling your attention to the address of Prof. R. Lankaster, as President of the Society in Great Britain for the Advancement of Science, I find the King has conferred a title on him, although an advocate of Modernism.

The extract accompanying refers to the discovery of the beautiful blue marble, named Sodalite, from Hastings, Canada, a member of Feldspar family. Some time since a gentleman showed me a specimen polished. The museum should possess one also.

CANADIAN BLUE MARBLE.

MAGNIFICENT LONDON PALACE TO HAVE SIXTY TONS OF SODALITE CORNICES.

The Princess of Wales has to her credit one of the greatest sensations in building material in many years, nothing less than the re-introduction of "blue marble" for interior decoration. It is used in the outer entrance hall of Brock House, the great Park Lane palace that Sir Ernest Cassel bought two years ago from Lord Tweedmouth, and that he has fitted up in marble and with a richness of detail that even the Cæsars never dreamt of. The work now nearing completion makes London stare. The main staircase contains 800 tons of statuary marble from Sarravezza. Michael Angelo, sent from the Vatican in 1490 to prospect, was amazed at the beauty of this material, and it is said his report to the Pope deprecated its quality so that he might obtain a monopoly of the mine for his own sculptures. From that date all Angelo's masterpieces were chiselled from these Tuscany marbles.

In contrast with this dazzling white marble is the great outer entrance hall, pilastered with unique blue marble, knowledge of which had lapsed for many years. Credit for the rediscovery of this marble belongs entirely to the Princess of Wales, whose attention was drawn to some fragments of the blue stone presented to her at the time of her voyage with the Prince to Canada.

When Marlborough house was undergoing overhauling and improvements, the Princess showed her specimens to Mr. Allom, expressing great enthusiasm as to their beauty of color, and her desire to have the quarry found and the beautiful blue Sodalite made use of. Mr. Allom set out to prospect for the blue marble, and with the able help of the Geological Survey Department of Canada, discovered the mine in Hastings County, in the centre of Ontario.

With a few friends Mr. Allom promptly bought the mine outright, and the blue stone now beautifies many of the Princess of Wales' rooms. The peculiar hardness of the mineral renders the work of cutting most difficult, and much time and ingenuity, both here and on the continent, have been expended, but at last the difficult process of cutting and moulding appears to be solved.

At Brook House the same blue Canadian marble mixed with pavonazzo will adorn the sumptuous outer entrance hall when it is completed. Hundreds of men are now working to get the necessary quantity of sixty tons cut and moulded to form the cornices and pilasters of the apartment.

Nature informed its readers recently that the remains of an immense Rhinoceros was just discovered in Austria, with flesh and skin in fair preservation. It may have been imbedded in glacial clay perhaps.

Notes Geological and Antiquarian.

Read before the Hamilton Scientific Association, March 2nd, 1908.

BY COL. C. C. GRANT.

Talk as we may, as members of the Hamilton Scientific Association, of confining ourselves to the mere organic remains of a Silurian district little known on the American continent, assuredly the restriction was never intended by the early liberal original framers of the rules of the Association, still existing for the guidance of the members, and which, as far as the writer can see, have never been cancelled.

The Geological Section of the Association always accepted that prominent assertion in every copy of our Proceedings, that "the writers were solely responsible for statements published." But even years ago we recognized the fact, as Sir A. Geikie stated, that the flint-flake human productions, Palæolithic or Neolithic specimens, should be recognized also as scientific advance, inasmuch as human productions wherever buried also revealed the past history of life on earth, perhaps even better than many of the elevated sea beds, where we have little difficulty in recognizing the coral and countless inhabitants which left their remains for science to record the history. Neither can we altogether separate Geology from the far more ancient science, Astronomy, since we are compelled to acknowledge that it alone possesses the key to the early creation of the earth we inhabit.

Confined as our researches naturally must be, do we not find, even in the very interior of our limestone used for building purposes in this city, indelibly recorded by the Great Creator far more reliable evidence than Pagan tradi-

tions, which in the dark days of Hebrew adversity preceded even with them that medieval Christianity which science unquestionably accepts, while denounced as "Modernism" by His Holiness the Pope himself, who claims that even the advocates of heresy in the ancient days among various Christian denominations also acquiesced in the views he entertains. Well, after all, we must admit the correctness of this assertion. Denial is impossible if any reliance can be placed on the daily press of Canada.

Now let us take a subject which, as far as I can see, is absolutely impossible to divorce or separate from Geology—Botany. It possesses an older claim to scientific investigation regarding the origin of plant life. This locality certainly possesses probably a little known but very important collection of early sea plants, ranging from the Medina Grey Band to the Niagara Barton's inclusive. As far as the writer recollects, he called the attention of the Section to this when the late Prof. Nicholson, in *The Palæontology of Ontario*, expressed a doubt he entertained regarding the real nature of what I believe to have been imperfect specimens from the Clinton rocks at Hamilton. Sir W. Dawson noticed the absence of bituminous matter which he expected to find in the first fossilized remains forwarded and shared, I think, in the doubts of the Toronto Professor, but he changed his opinion when we were subsequently enabled to furnish him with better specimens than the ones he received previously.

Your collector, on submitting some Clinton forms to the late Dr. James Hall, of Albany, mentioned that a few Canadian Palæobotanists had expressed doubts regarding the true nature of the sea plant he described, and figured under the name Buthotrephis. "Well," he remarked, "they never could have seen such ones as you gave me, or the ones in the side case of the museum." The writer thinks the Doctor's B. gracilis may merely represent a detached branch of a plant such as we have here in our local

Clinton beds in a large flag. It has a conical root; a flattened main stem which is furnished with numerous alternating branches. The latter are thick near the root, but gradually get quite thin when they reach the top. Had I not obtained the entire plant, and found only its detached branches, I certainly would have no hesitation in asserting they represented distinct species or varieties. This, taken into consideration with the acknowledgment we received from the authorities of the British Museum, that specimens of fossil plants from Hamilton had arrived, clearly establishes Dr. Hall's claim as regards the original sea plant he discovered in the lower Silurians of New York State,

Perhaps the late Sir W. Dawson was the first to recognize marsh plants from the Clinton iron band of the escarpment here.

It was not until the sedimentary Devonian rocks, three miles in thickness, were deposited that we find positive proof of the former existence of true land plants.

The members of the Section may naturally see no necessity for repeating things they are already acquainted with. Admitting this, the object I had in view was to call your attention to the gross ignorance of scientific facts recently displayed at Toronto by some of the clergy of this enlightened Province. A report of the proceedings appeared in a copy of *The World* of that city and was furnished probably by some one who recognized the writer as one who held similar views to the Rationalists of the Old Country. A notification of an intended work on this very subject was also received about the same time from an English publisher, and to both I am gratefully indebted.

In submitting the extract I received to the Section, it is unnecessary to refer to the theological views of some of the members of the Bible League. The Rev. Geo. Jackson, of Shelbourne Street Methodist Parsonage, in a letter to *The Toronto Globe*, calls attention to the ignorance of his

clerical brethren regarding that point. Heaven knows Ontario possesses more than we want of "Sham Parsons" or medical quacks without importing a fresh supply of either from the United States.

One of the speakers at the meeting is reported to have stated: "At the present day we are face to face with one of the most interesting and suggestive facts in the whole field of historic-scientific investigation, namely, that no creature that wore the human form had an existence on the earth earlier than from six to twelve thousand years ago."

When the learned gentleman made such an assertion, he betrayed his unbelief in what has been incorporated in the authorized version of the English Bible of King James. True, perhaps, to compromise matters with the Geologists, he adds a paltry six thousand years to Archbishop Usher's calculation regarding the date of the Creation, but he appears to be as ignorant of recent discoveries as other reverend gentlemen who addressed the meeting. Has he heard of the human skeleton now in the British Museum lately found in Egypt, interred eight or ten thousand years ago, with the stone implements he used in life lying beside him; of the scores of flint arrowheads, celts, etc., obtained by the English general, Rivers, and American Antiquarians, from the same country, antedating the time when Egypt was possessed by a more civilized people? Has the learned gentleman heard of the recent discoveries in the caves of France and Germany, of the human remains found there, when Africa and Europe were joined by land? Or has he learned anything respecting the Mediterranean elevated Pliocene sea beds, which the famous Italian Astronomer, Secchi, informs us contained in an undisturbed bed the bones of an entire family drowned at sea, apparently?

No doubt the reader may remark an attempt on the part of the Bible League at Toronto to re-open a question which the author of *The Warfare of Science* considered settled long since.

The late Duke of Argyle asserted that Egypt displayed from the earliest times no indication whatever of a Stone Age, but reached a high civilization at once. Huxley pointed out to him the erroneousness of this statement, and the Duke admitted he was mistaken and was compelled to withdraw it as is stated in *The Warfare of Science*.

The writer remarks even already, when criticized for inaccurate and reckless statements, some few of the speakers at the meeting protest that the reports misrepresented what they actually said. Perhaps the imported Professor of the Boston University may also deny he uttered the words we find recorded in *The Globe*, a Toronto paper. "It has been claimed by many Scientists that man has been on earth for periods variously estimated at from two hundred thousand years to eight or nine million years. The foremost scientists after investigations admitted that human life came after the Glacial period, and that this Glacial period occurred at from seven thousand to twelve thousand years ago."

Now, with the single exception of the late Sir W. Dawson, of late years I have never known any leading Geologist to publish his belief that man first appeared on earth at or near the close of the Glacial Age. But if our ancient lake beach known as Burlington Heights (formed since the Glacial period, overlying its deposits) was raised in twelve thousand years, the writer would simply look on it as just as miraculous as the Hebrew tales of Jonah's whale, or Joshua's arresting the sun in its course.

There may be some truth in what the speaker mentioned, namely: The secular press of the city (Toronto) gave more space to a dog-fight than they would give to a bible conference—if the statement proves true (we doubt it however), the newspapers there appear to have formed a more correct estimate of the orators than the large audience the various churches brought together, which, we were informed, were in entire sympathy with the speaker.

What else could we expect? Natural history, etc., has been long neglected, and the universities here teach a higher class than he is likely to find in such a religious assembly. instead of preferring vague charges and appealing to ignorance at public meetings, assailing others who are infinitely superior to themselves as regards knowledge and true Christianity, why, may I ask, do they never bring reliable proof in refutation of the men conducting the excavations in Egypt, Babylon, etc. Take, for instance, scientific Americans and others.

"The oldest city in the world is "Nippur," the older Bel of Babylon. The foundation was laid 7,000 years B.C., ruins lately unearthed."

"Egypt has yielded another find to De Rustaffaell's researches. In the desert of Upper Egypt, on the left bank of "the Nile," he found among the remains of Palæolithic things flint factories, a number of crude, weathered limestone vessels, resembling troughs. They are certainly older than "the Neolithic Age," which covered a considerable period there before the advent of the first dynasty."

It appears to me inexcusable for a clergyman of any denomination, now, to be unacquainted with recent discoveries in Egypt, Babylon and elsewhere. Chaldean records plainly demonstrate that the Jewish people, who attributed to Moses the writings of early times, borrowed largely from the library of the last great Assyrian King. Take, for instance, "The Deluge." In the original version of "old Babylonian myths" it is distinctly recorded as "a tale or story." "Ishtar" (Venus) plays, we are told, a prominent part in "The Flood." In the Ninevite account, Noah sent out the dove, swallow and raven. In this, no doubt, "The League" would simply find confirmation of what is stated in "Genesis." The writer received an account of the French explorations (under De Morgan) at the ancient City of Susa. He laid bare the ruins of several

cities, one above the other. Beneath all he found an older settlement containing rude flint implements and pottery. His most important find was a fine Stela of Naram-Sin, son of Sargon, 3,800 B.C.

FROM MYTHS OF EGYPT

German Savant says Old Testament was reproduced. Berlin, July 10.—The theological world of Germany is greatly moved by the appearance of "Egypt and the Bible," by Professor of Divinity Volter, who states that the writers of the earlier books of the Old Testament only reproduced Egyptian Sagas and Myths, slightly altering them to suit the tendencies of the Hebrews.

The history of Abraham, Isaac, Jacob, Esau, Joseph and Moses, he declares purely Egyptian with exact counterparts in Egyptian Mythology.

Beginning with Abraham, Volter shows that the story of God visiting Abraham at Mamre and the destruction of Sodam and Gomorrah have exact parallels in the Egyptian Sagas. Abraham corresponds to the Sun-God. Nun's wife, Nunet, like Sarah, had her first child in her old age. Both were children of promise through whom the future world should be blest.

Note well that in the face of this extract and others in my possession, one of the speakers of the League boldly asserts: Egyptian excavations of late fully confirm the truth of the earlier Hebrew writings.

NOTES

On comparing this Trilobite tail, obtained from a Trenton limestone in "the Glacial (Ene) clay," Winona, with rather an indifferently preserved tail shield of Chapman's "Asaphus Canadenses." It appeared to me to bear a nearer resemblance to the Utica Shale Trilobite than to a platycephalus Trenton. Perhaps it might be owiug to sight-failure on my part.

Discovery of Barton Niagara beds west of Dundas, by Horace Sayman. A visitor to the City Museum called attention recently to some minerals he brought from rocks west of Dundas—Mineral Tar, Galena, Pyrites. They come from beds at or near the level of Carpenter's Quarry, abandoned many years ago on Barton and Glanford road. I think no one expected that the Barton rocks would ever be found there. The visitor brought no Fluor, which is common in mineral quarry—Carpenter's. The Tar slightly differs, but I think I am right in assigning their position.

Report of the Astronomical Section For 1907-08.

The officers of the Astronomical Society decided last season that for several reasons it was not advisable to attempt to reorganize the Society at that time. Consequently the affairs of the Society are practically the same as when last reported.

All constitutional requirements and Government regulations have been complied with, so that the charter is alive and ready for reorganization at any time.

Of course no fees have been collected, but it is hoped that the members of this section have kept up their membership in the Scientific Association.

The prospects are reasonably bright for a revival of the interest in the Society next fall, and if this develops the work of the Society will then be resumed.

G. PARRY JENKINS,
Acting President.

E. H. DARLING,
Acting Secretary.

Annual Report of Camera Section
May, 1908.

The Camera Club, since the equipment of its new quarters at 104 King Street West, has had a very busy and interesting session.

While the cost of equipping our new Club Rooms has been beyond our resources, a new interest has been created in the work of the Club, and we are now in possession of up-to-date rooms and have some inducement to offer in this way to new members.

We are greatly indebted to a number of the older members for donations towards the equipment of the premises, and hope, when we have paid off all this expense, to go on improving the surroundings and keep ourselves up-to.date.

On October 27th the opening of the New Club Rooms took place, when an exhibition of lantern slides was given in the Museum and attended by a large number of members and friends.

This was followed by an adjournment of the meeting to our new quarters, where a pleasant social hour was spent and the serving of light refreshments added to the evening's entertainment.

During the past session three meetings have been held each month, and many of the practical demonstrations have been of exceptional interest to the amateur camerist and greatly appreciated by our members.

In March we had an open meeting, when an interesting exhibition of lantern slides was shown on the screen.

At the end of the same month the Exhibition of Prints was held, and a large namber of people took advantage of

seeing these during the three days they were on view to the public.

A number of new members have been added to the Club during the year. Though many of these, having the advantage since March 1st of getting their fees to cover the period to June 1st, 1909, date for the coming year.

At the Annual Meeting, held on April 13th, the following officers were elected for the ensuing year :

President—C. A. Herald.

First Vice-President—B. H. Higgins.

Second Vice-President—George Lees.

Secretary—Arthur Smith.

Committee — { Jas. B. Bertram.
Wm. Acheson.
E. G. Overholt.

An outing to Forks of Credit has been arranged for Victoria Day, when it is hoped there will be a large turn-out of members and their friends, as well as many of the old members of the Club, this outing to be known as an Old Members' Reunion.

The Club now looks forward to a very great increase in membership, and along with this an increased enthusiasm and interest in the Art and Science of Photography.

SINCLAIR G. RICHARDSON,
Secretary.

Curator's Report.

SEASON 1907-08.

Having so recently resumed the office and duties of Curator, I regret I am unable ta call your attention to any additions to the Museum cases presented during my absence.

The Council furnished lately some cases which were much wanted. This will enable us to make a few necessary alterations in our overcrowded shelves.

A local museum, as was pointed out by our President, Mr. Alexander, several years ago, should contain as complete a collection as possible of the Fauna, Flora and Minerals of the locality. This ought to be the principal object in view. Since the removal of the animals loaned to us formerly, unfortuately we were unable to replace any of them. I remember some time since pointing out to an English visitor a rediculous blunder made by an English Artist regarding "the Snapping Turtle." I could only show him a very poor specimen of the one thing he had never seen.

Any contribution of specimens of snakes, etc., would be acceptable and thankfully received.

CHAS. COOTE GRANT,
Curator City Museum.

Hamilton Scientific Association.

Treasurer's Statement For Financial Year Closing 14th May, 1908.

RECEIPTS

Balance from 1907	$ 67 03
Government Grant	400 00
Members' Fees (regular)	104 00
Members' Fees (Photographic Section)	29 00
Donations	10 00
Horticultural Society and other rent	16 50
Show Cases (sold)	4 00
	$630 53

EXPENDITURE

Rent of Museum	$130 00
Rent of Dark Room to July 1st, 1907	9 00
Rent of Room and Music for opening night	23 00
Gas Co., account $14.80, Lamps $2.35	17 15
Caretaker $35.00, cleaning $3.25	38 25
Insurance	16 00
Printing Annual Reports (on account)	175 00
Printing and Engraving	105 35
Postage and Stationery	25 50
Lecture expenses and reports	26 60
Show Case	13 50
Sundry Accounts	14 10
	$593 45
Balance on hand	37 08
	$630 53

P. L. SCRIVEN, Treasurer.

This is to certify that we have examined the vouchers and found them correct. May 13, 1908.

E. H. DARLING,
F. H. WINGHAM, } Audiiors.

R. J. HILL, President.

J. H. BALLARD, Secretary.

LIST OF EXCHANGES

I.—AMERICA.

(1) Canada.

Royal Astronomical Society of Canada............Toronto
Canadian Institute...............................Toronto
Natural History Society of Toronto..............Toronto
Department of Agriculture........................Toronto
Library of the University........................Toronto
Public Library...................................Toronto
Geological Survey of Canada......................Ottawa
Ottawa Field Naturalists' Club...................Ottawa
Ottawa Literary and Scientific Society...........Ottawa
Royal Society of Canada..........................Ottawa
Department of Agriculture........................Ottawa
Entomological Society............................London
Kentville Naturalists' Club..............Kentville, N.S.
Murchison Scientific Society..................Belleville
Natural History Society.........................Montreal
Library of McGill University....................Montreal
Nova Scotia Institute of Natural Science.........Halifax
Literary and Historical Society of Quebec..........Quebec
L'Institut Canadien de Quebec......................Quebec
Natural History Society of New Brunswick......St. John
Manitoba Historical and Scientific Society......Winnipeg
Guelph Scientific Association......................Guelph
Queen's University...............................Kingston
Natural History Society...........................Niagara

(2) United States.

Kansas Academy of Science.................Topeka, Kan.
Kansas University Quarterly............Lawrence, Kan.

LIST OF EXCHANGES

American Academy of Arts and Sciences....Boston, Mass.
Psyche..............................Cambridge, Mass.
Library of Oberlin College.................Oberlin, Ohio
American Assoc. for the Advancement of Science ....
..................................Salem, Mass.
Museum of Comparative Zoology.......Cambridge, Mass.
American Dialect Society..... ....Cambridge, Mass.
United States Department of Agriculture
..........................Washington, D.C.
Biological Society of Washington......Washington, D.C.
Philosophical Society of Washington... Washington, D.C.
Smithsonian Institute........... ......Washington, D.C.
United States Geological Survey.......Washington, D.C.
American Society of Microscopists..........Buffalo, N.Y.
Buffalo Society of Natural Sciences..........Buffalo, N.Y.
California Academy of Sciences.......San Francisco, Cal.
California State Geological Society....San Francisco, Cal.
Santa Barbara Society of Natural History
....San Francisco, Cal.
University of California.......... ....Berkley, Cal.
Minnesota Academy of Natural Sciences
....Minneapolis, Minn.
Academy Natural Sciences....... ......Philadelphia, Pa.
Academy of Sciences......................St. Louis, Mo.
Missouri Botanical Gardens...............St. Louis, Mo.
American Chemical Society...... ....New York City
New York Microscopical Society..........New York City
The Linnean Society.....................New York City
American Astronomical Society.... ......New York City
American Geographical Society...... ....New York City
New York Academy of Science...........New York City
Terry Botanical Club.....................New York City
Central Park Menagerie........... ....New York City
American Museum of Natural History ....New York City
Scientific Alliance.........................New York City
Cornell Natural History Society.............Ithaca N.Y.
John Hopkins University...... ....Baltimore, Md.

Kansas City Scientist..................Kansas City, Mo.
Wisconsin Academy of Science, Arts and Letters..........................Madison, Wis.
Soc. of Alaskan Natural History and Ethnology ....Sitka, Alaska
University of Penn...... ....Philadelphia, Pa.
Franklin Institute.......................Philadelphia, Pa.
Brooklyn Institute of Arts and Science....Brooklyn, N.Y.
War Department................ ......Washington, D.C.
Field Columbian Museum.. ....Chicago, Ill.
Academy of Sciences........................Chicago, Ill.
Agricultural College...... ....Lansing, Mich.
Colorado Scientific Society........... ......Denver, Col.
Museum of Natural History................Albany, N.Y.
State Geologist...........................Albany, N.Y.
Rochester Academy of Sciences........ Indianapolis, Ind.
Indiana Academy of Sciences...... ....Indianapolis, Ind.
Davenport Academy of Natural Sciences..Davenport, Iowa
Pasadena Academy of Sciences............Pasadena, Cal.
U. S. Board of Geographic Names......Washington, D.C.
Lloyd Library.........................Cincinnati, Ohio
Colorado College.......................Colorado Springs
Public Museum of the City of Milwaukee......Milwaukee

(3) West Indies.

Institute of Jamaica............ ......Kingston, Jamaica

(4) South America.

The Royal Agricultural and Commercial Society of British Guiana.......................Georgetown

II.—EUROPE.

(1) Great Britain and Ireland.

England.

Bristol Naturalists' Society...............Clifton, Bristol
British Naturalists' Club............ ....Bristol
Literary and Philosophic Society of Leeds..........Leeds
Conchological Society.......................Manchester

Royal Society............................London
Royal Colonial Institute........................London
Society of Science, Literature and Art............London
Geological Society..............................London
Manchester Geological Society...............Manchester
Mining Association and Institute of Cornwall...Camborne
Cardiff Photographic Society.......................Cardiff
Owens College Conchological Society.........Manchester

Scotland.

Glasgow Geographical Society..................Glasgow
Philosophical Society..............................Glasgow

Ireland.

Royal Irish Academy..............................Dublin
Royal Geological Society of Ireland...............Dublin
Naturalists' Field Club...........................Belfast

(2) Austria-Hungary.

Anthropologische Gesellschaft...................Vienna
K. K. Geologische Reichsanstalt..................Vienna
Treutschin Scientific Society.................Trentschin

(3) Belgium.

Societe Geologique de Belgique.......................Liege

(4) Denmark.

Societe Royal des Antiquaries du Nord.......Copenhagen

(5) France.

Academie Nationale des Sciences, Belles Lettres
et Arts..................................Bordeaux
Academie Nationale Science, Art et Belles Lettres...Caen
Academie des Nationale Science, Art et Belles
Lettres...................................Dijon
Societe Geologique du Nord..........................Lille
Societe Geologique du France.......................Paris

(6) Germany.

Naturwissenschaftlicher Verin..................Bremen
Naturwissenschaftlicher Verein...............Carlsruhe

(7) Russia.

Comite Geologique........................St. Petersburg
Russich-Kaiserliche Mineralogische Gesellschaft
..................................St. Petersburg

III.—ASIA.

(1) India.

Asiatic Societies of Bombay and Ceylon..........
Asiatic Society of Bengal.......................Calcutta
Geological Survey of India.......................Calcutta

(2) Straits Settlements.

The Straits Branch of the Royal Asiatic Society..Singapore

(3) Japan.

Asiatic Society of Japan................................Tokio

IV.—AFRICA.

(1) Cape Colony.

South African Philosophical Society............Capetown

V.—AUSTRALIA.

(1) Australia.

The Australian Museum..........................Sydney
Royal Society of New South Wales...............Sydney
Linnean Society of New South Wales............Sydney
Royal Anthropological Society of New South Wales
....Sydney
Australian Natural History Museum..........Melbourne
Public Library of Victoria......................Melbourne
Royal Society of Queensland.....................Brisbane
Queensland Museum............................Brisbane

(2) New Zealand.

New Zealand Institute.....................Wellington

(3) Tasmania.

Royal Society of Tasmania..................Hobartown

EXECUTIVE

LYMAN LEE, B.A., Chairman.

ADAM BROWN,
Hon. President and Charter Member.

A. ALEXANDER, F. S. Sc., President.

H. B. WITTON,
1st Vice-Pres., Past Pres. and Charter Mem.

MATTHEW LEGGAT,
2nd Vice-Pres. and Charter Member.

REV. S. LYLE, Past President.

A. T. NEIL, Past President.

DR. MORGAN, Past President.

J. M. DICKSON, Past President.

GEO. L. JOHNSTON, B.A., Past President.

R. J. HILL, Past President.

COL. C. C. GRANT, Curator.

P. L. SCRIVEN, Treasurer.

G. PARRY JENKINS, F. R. A. S.,
Corresponding Secretary.

JAMES GADSBY

A. H. BAKER

J. M. WILLIAMS

WM. ACHESON

REV. W. DELOS SMITH

J. F. BALLARD, Recording Secretary.